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The
Technique of Controversy

Principles of Dynamic Logic

By

BORIS B. BOGOSLOVSKY

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PREFACE

When the author was engaged in writing this book, he was often asked what he was writing about. The answer that the book was going to be about certain problems of logic almost invariably brought the reply: "About logic? But why have you chosen such an abstract topic? Why not write about something closer to life and more useful?"

The position of logic in public opinion is indeed peculiar. On the one hand, compliments, like "He has such a logical mind!", and rebukes, like "Where is your logic?", are quite common and effective. On the other hand, logic as a science or academic subject has the reputation of being something antiquated, scholastic in a bad sense, and utterly divorced from life.

This has led the writer to state emphatically at the outset that the book, at least in its purpose, is primarily practical both in a broad and in a narrow sense of the word.

In fact, this book had its origin in the writer's attempt to find for himself some guiding thread in the maze of modern reasoning, sometimes so puzzling. The whole book is a continuous effort to work out practical devices for the solution of the concrete problems which confront us in actual everyday thinking.

This practical aspect of Dynamic Logic must be constantly borne in mind, lest its whole conception be seen in the wrong light.

In spite of its name and the position which it holds in a book the Preface is usually the last thing to be written. Now that this work is completed my thoughts turn with gratitude to Dr. John Dewey for his valuable criticism during the preparation of the book. I also extend my sincere thanks to Dr. William H. Kilpatrick and to Dr. Rudolf Pintner for their helpful suggestions. Lastly, I wish to express my deep appreciation of the spirit of comradeship with which Dr. Gladys C. Schwesinger gave her time reading the manuscript.

B. B. B.

December 1927.

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of life and philosophy. Defects in reasoning itself, in its method and technique, must also be responsible for that —and to no small extent. Our manipulation of facts, our habitual ways of thinking, our Logic also must play quite a prominent and probably the most decisive part in making our discussions so inefficient, loose, and inconclusive. To what extent modes of reasoning are indeed important and decisive is probably nowhere seen so well as in disputes between a "modernist" in the broad sense and a person of strictly classical traditions, again in the broad sense of the words.

It makes no difference in what particular field of human experience the conflict may arise It may be a dispute between a modernist and a fundamentalist, an Einsteinian and a strict Newtonian, an "idealist" and a "pragmatist," an admirer of classical literature and a futurist, an old-fashioned pedagogue with definite ideals, methods, and "minimum essentials" and a modern educator interpreting education as a growth, with greater emphasis on process than on output, and so on But in all cases the general attitude, the fundamental associations of reasoning, the very grammar of thought, so to speak, of the debaters, when analysed, are strikingly different

The opposition between the modern and the "classical" (in other words, that which is based on and selected from the past) introduces into the problem of reasoning a historical factor, the element of time. The temporal factor may be considered from two aspects. firstly, changes produced by time in an individual or in a synchronous group of individuals, such as growth, maturity, and decay of an individual or of any given generation, and, secondly, changes brought about by time in the development of the human race or of a nation or of a group of nations as a whole.

It will be more convenient to omit the former changes, partly because they would shed but little light on the problem in question, and also because they will be discussed in more detail later, in connexion with other related problems. It is worth while, however, to dwell a little on the second kind of changes.

One of the striking facts in the history of science is the comparative neglect of changes in ways of human thinking, of differences in the technique of thinking through different cultural epochs. Certainly we often speak of the mediæval mind as contrasted with the modern mind, or of the difference between Oriental and Western minds; but usually by "mind" is meant mostly the cultural background, the stock of information, certain attitudes, mainly ethical, social, or æsthetic, or sometimes typical standardized symbols and combinations of ideas. For it is an almost universal conviction that the laws or norms of thinking are nearly the same for all human beings and for all times. In other words, while the "psychological" differences are fully recognized, the "logical" differences generally are hardly supposed to exist. Logic as the summary of the canons of human reasoning is supposed to be always and for ever the same. As it is sometimes concisely put, two times two has been and always will be four, for everybody and everywhere. This is to a very great degree true, but to an even greater degree it may be false. It is enough, for instance, to set side by side Plato's and Socrates' discussions, Aristotle's treatise, mediæval dialogues like *Cur Deus homo*, Oscar Wilde's essays, Leo Tolstoy's writings, and the works of Kant and Dewey, in order to realize that for different minds and times, a difference in ways of thinking, in the technic of reasoning, in logic[1] itself, really does exist.

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[1] By logic here the actual habits of thought and the prevailing modes of reasoning are understood, but not their formulations and interpretation of the formulations. Formulations and interpretations of the supposedly universal and eternal principles of reasoning have certainly been studied by Logic and Philosophy. As a matter of fact this is almost the only thing which Logic has treated since mediæval times. To differentiate between logic as actual ways of thinking and Logic as an organized discipline, in the following presentation the former will be spelled with a small "l" and the latter with a capital "L."

The curious fact that these differences have never been the object of a systematic scientific investigation and have been completely neglected by Logic as an organized science, must be explained mostly by the one-sided attitude towards Logic which has been accepted. Logic has nearly always posed as an exclusively normative science, predetermining all investigation in every other field of knowledge, and has looked on itself as a preliminary condition positively indispensable to any intelligent activity. Logic, either studied purposefully or acquired unconsciously, has always been considered the Propædeutic to all other sciences and the very *scientia scientiarum* itself. This is, to a large degree, true, but again, to a no smaller degree, false. Logic, like all other sciences, has not only organized and controlled the material with which it has dealt, but has itself also been controlled and organized by the material, that is, by actual human reasoning In its origin and growth, as far as any real growth has taken place, Logic, like all other disciplines, has observed facts and made generalizations—laws—on the basis of the facts observed. In this sense, contrary to the traditional view, everything else—life, human actions and behaviour, all intellectual activities and sciences—are the indispensable preconditions of and propædeutics to Logic.

This double nature of Logic is well illustrated if we call Logic the grammar of thought On the one hand, in one of its aspects, the grammar of any language is certainly normative, but, on the other hand, it is also obvious that no grammar does anything else than register and systematize significant events in the life-history of the language. In short, grammar in its growth does but follow the development of its language. In other words, changes in grammar are possible only because of previous changes in language and because of the sensibility (not always prompt enough) of the grammar to the life of its language. Logic, although of the same nature as grammar, has not shown any appreciable tendency to follow the development of actual modes of reasoning, partly because the changes in thought-processes have been fewer and less noticeable than in language, but chiefly because it has not possessed the needed sensibility to the changes, and therefore has neglected the specific peculiarities of different historical types of reasoning. Nevertheless, these specific peculiarities actually do exist.

Let us take, for instance, modern reasoning as contrasted with "classical." Even after a rather hasty preliminary inquiry, it is not difficult to see that modern reasoning does possess certain of its own specific typical characteristics. Thus, one of the most outstanding of its features is, perhaps, the tendency to increase the extension of abstract terms, to use them in the broadest sense possible. It looks, sometimes, as if certain abstract terms were obsessed with a peculiar kind of imperialism which makes them attempt to bring nearly everything under their dominion and jurisdiction. For instance, if we take the notion of "sex" or "love" in the new psychology as compared with the former meaning of the words, we see the tremendous expansion of their meaning. Nearly everything in human life now may be considered as a manifestation of "sex." For any one familiar with writings on psycho-analysis no lengthy testimony is needed.[1]

In modern religious thought the notion of religion itself provides a good illustration. From the old *religio* as "the connexion between God and man," or, as the definition given in the *Twentieth Century Dictionary*[2] has it, "the recognition of supernatural powers and of the duty lying upon man to yield obedience to these, the performance of our duties of love and obedience toward God," religion has now become merely a certain general attitude or a chief interest in Life. This again makes it possible to consider as a religion nearly any interest or tendency of the human mind, if only it be sufficiently strong and persistent.

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[1] See, for instance, J. B. Watson, *Psychology from the Standpoint of a Behaviorist*, Philadelphia and London, 1919, p. 201; or S. Freud, *Collected Papers*, London, 1924, Vol. II, p. 164.

[2] *Chambers's Twentieth Century Dictionary of the English Language*, London, 1909, p. 788.

In sociology the tendency of modern concepts to unlimited expansion is well exemplified by the notions of "society" and "social." In the terms of up-to-date discussion, everything, either in origin or in manifestation, is so exclusively social that it does not leave any room for the contrasting idea of "individuality" and "individual." The attitude is so definite that Albion W. Small even suggests the abolition of the word "individual" and the use of the word "socius" instead. "The socius is that literal factor within the human whole which we now find in the place occupied by that discredited hypothesis, the individual."[1]

The most recent politics, theoretical and practical (Russia), has as its cardinal notion something which includes within itself nearly everything, that is, the opposition between "capitalistic" and "socialistic" or "communistic" or "proletarian" Everything may be capitalistic or proletarian—ideas, art, science, and any particular art or science, such as biology, language, appearance, dress, dancing, and the like. The notion is so imperialistic and aggressive that there is nothing incredible in a story about peasants in a Russian village who, after the October revolution, in the endeavour to be "100 per cent proletarian," destroyed a flock of full-blooded cattle on the next estate, because they were "bourgeois," "capitalistic" cattle.

The evolution of the meaning of the word "experience" in philosophy is also very illustrative Instead of the "experience" of the Greeks, which was contrasted with theory, or experience as against the intuition of the mystics, we now have experience versus nothing, experience in its broadest possible sense. It includes both everything that could possibly be experienced (all possible kinds of objects) and all possible experiencing (all so-called subjective elements) or practically everything conceivable. "Experience is the ultimate universe of discourse "[1]

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[1] Bodenhafer, in *The American Journal of Sociology*, 26, 596 f., March 1921

In the field of Education many ideas have passed through the same transformation. The notion of education itself, which primarily meant "schooling," often something not very much beyond the mastery of the three R's, has now come to be understood as "a constant reorganization or reconstruction of experience,"[2] which is broad enough to cover nearly all manifestations of life Immaturity, as the possibility of growth and the ability to develop, become the general characteristics of all living beings. The modern conception of subject-matter includes a much larger range of situations and events than did the notion of subject-matter a few decades ago. The same is true about the modern notions of method, curriculum, study, work, play, practical studies, discipline, moral education, and so on All these concepts show a very pronounced trend towards a constant widening of their meaning and a corresponding increase of their content

The above examples from different fields of modern thought illustrate clearly enough the centrifugal tendency of abstract terms towards constant and persistent expansion. It would be only natural to expect this "imperialistic" tendency to be opposed to all fixed limits and definite border-lines, and this is actually the case

This introduces another characteristic of modern thought, a dislike for definitions

As Spinoza long ago pointed out, definition is always limitation, it is always a separation of what belongs to a concept from what does not In other words, it is the establishment of a definite barrier around the dominion of a concept, so that it may not illegitimately claim a larger territory than is given to it by its definite meaning.

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[1] Adapted from Bush in *The Journal of Philosophy*, 6, 175–6 (April, 1909) See W H Kilpatrick, *Source Book in the Philosophy of Education*, New York, 1923, p 19

[2] J Dewey, *Democracy and Education*, New York, 1920, p 92

Modern dynamic thinking cannot avoid opposition to every limitation upon the possible constant growth of its concepts, and is therefore rather hostile to definitions. From the point of view of logical technique and routine, the difference of their attitudes towards definition is probably the greatest difference between classical and modern thinking.

The well-known college story of the old-fashioned professor of physics who started his course by saying, "Physics is a science which consists of two parts: one I am going to teach you now, and the other I have on my bookshelf at home," well shows the part which definition played in mediæval thinking. For the mediæval mind, definition, good or bad or even only verbal, was often the alpha and omega of any knowledge and wisdom. Mediæval scholars nearly always began with definition and would often finish with it. Their textbooks were sometimes nothing more than a collection of definitions. But if we want to see how up-to-date a modern textbook is, we must note how many definitions there are and where they are to be found. The farther they are from the beginning and the fewer in proportion to the general content of the book, the more modern is the textbook.

This retirement of definition is not a local event limited to elementary textbooks. In theory and in practice, there is no sharp border-line or essential difference between elementary schools, on the one hand, and higher learning or any form of scientific research, on the other; so this attitude towards definitions is creeping into all studies and scientific investigations. Very instructive university courses on the nature of thinking, for example, may proceed without a definition of what thinking is. One of the leading authorities on intelligence-testing, in his course on measuring intelligence, defines intelligence as "that which is measured by intelligence-tests."

But to what extent the definition is considered unnecessary in modern thinking, is probably best seen in the change of customs, of traditions, and, if it is possible to say so, of good manners in semi-formal and informal oral discussions, which as a matter of fact are always the most influential and representative factors in the development of thought. Socrates' reasoning, Plato's dialogues, and mediæval disputations were to a very large degree only a hunt for definitions. In any stage of the argument it was quite legitimate for any participant to ask for a definition, and it was the duty of the person asked to give the definition. If he could not give it, that was his fault, and a testimony to his incompetence. In modern discussion, to ask for definition, and especially to insist on it, may even appear like obstruction, unnecessary hindrance, or at least bad manners. Often the questioner himself is put on the defensive by the answer, "I cannot give the exact definition. Everybody can see from the context what I mean by that We do not need dry dictionary definitions—anyway, they mean very little or nothing and are of no use in flexible and creative thinking." And sometimes this is really the best possible, or at least the most practical, attitude towards the situation. For most people who use such terms as experience, society, social, individual, environment, situation, subject-matter, Philosophy of Education, etc., fairly intelligently have no definition of these concepts satisfactory even to themselves, and the attempt to find a definition would certainly hold up the interrupted debate for a long time.

As an inevitable consequence of this dislike and repudiation of definition, comes the loose and inaccurate use of abstract terms, which in turn results in sweeping statements and so-called half-truths, which really are often but one-fourth, one-eighth, one-sixteenth truths and even smaller fractions. Indeed, if we do not know the exact meaning of a concept, and consequently the range of facts and ideas included in it, we cannot apply the concept in our judgment in any exact and definite way. Thus it is small wonder that everywhere we have so many half-truths—in advertisements, in papers, in literature, and even in scientific and semi-scientific books.

To present these tendencies, then—namely, the constant inclination of concepts to trespass on their own borderlines, the dislike of definitions, and the tendency to sweeping statements—as the outstanding characteristics of modern thought looks, especially from the point of view of traditional Logic, like a definitely severe, unfriendly, and disqualifying criticism. It would, indeed, be so if the situation were as simple as it may appear from the brief account here presented But actually it is by no means so simple. First of all, the tendency of abstract terms towards constant extension (the most important factor of all, of which the two other tendencies are only correlate inferences) is in itself only a form of the general tendency to broaden units of thought, to make our judgment more comprehensive. In other words, it is only a tendency towards abstraction and generalization, which is not only a process more than legitimate in itself, but is the very core and essence of all our thinking, all our science, and all intelligence, if not actually intelligence itself. From that point of view it must *a priori* be not only not negative but highly constructive On the other hand, the facts themselves, the practical results, stand very strongly for modern ways of thinking The most typical forms of modern thinking as characterized above are often to be found in the youngest, most vigorous, and probably most promising sections of our science.

For good or evil, but definitely and beyond doubt, psycho-analysis and behaviourisms in psychology, sociology, with emphasis on "socius" and socialization, socialistic ideals in politics, a more liberal spirit in religion, pragmatic and postpragmatic philosophy, new education, and the like, will be for the immediate future, each in its particular field, very important factors. The new movements will be, directly or indirectly, the main means and sources of growth for the whole body of modern science and civilization, and the reasoning closely connected with such vigorous intellectual activities cannot be entirely wrong

The case of Education probably provides the best evidence of it. Among the newer disciplines, probably the most consistent use of new ways of thinking and the best examples of them can be found in modern educational thought, especially in the Philosophy of Education, as it is presented, for instance, by Dewey. In this case, the constructive and creative power of the new reasoning is quite distinct and unquestionable. The achievements of the new educational philosophy are especially instructive because its significance and its positive and, in the best sense of the word, progressive influence on educational thought are due not so much to any new materials or facts put forward as to methods of attack and specific ways of reasoning.

Thus the whole analysis of the situation shows that modern thinking exhibits two rather contradictory characteristics · on the one hand, certain considerable shortcomings or even, from the standpoint of formal Logic, fundamental defects, and, on the other hand, efficiency, decided creative power, and the intense satisfaction with which it is accepted by the modern mind.

As an explanation of the apparent contradiction a hypothesis is here offered which will be the main topic of the whole discussion, the principal points being as follows ·—

In its essence, the new reasoning is a great step forward and a much more efficient means for the rational comprehension and interpretation of the universe than was the old classical thinking. That is the reason for its creative and vigorous spirit. But, being relatively young, the new reasoning has not yet constructed and formulated any canons or norms of its Logic, and because of this either it is prone to go on in a haphazard way, to make mistakes and deviate from the right path, or it is forced to express itself in forms of the old traditional thinking, which are not at all capable of fitting into the new reasoning. This is the cause of its shortcomings.

The old reasoning is a generalization of experience in a static universe where motion is only an incidental, transitional, "imperfect" element, where everything consists of absolute, separated types or entities, stamped once and for ever, and where a few incidental and atypical crossbreed forms are considered to be deformities and perversions of the real realities. The Logic of this reasoning is based on and is an outgrowth of the law of thought: "A is either B or non-B."

The new reasoning is built on the experiences of a dynamic universe with motion as its essence, and with ceaseless change as its characteristic aspect, a universe conceived as a continuous succession of different but interrelated phases of one process which are all relative to each other, and perpetually flow one into another. The Logic of this reasoning must have as its foundation and root the law, "A is B and non-B at the same time." Only such a Logic can be a reliable guide in a dynamic universe and can satisfy the modern mind, which realizes more actively than ever before that we live in a world always new and changing every moment.

The main steps in the construction of a new technique of reasoning may be outlined as follows: Since workable and efficient canons of reasoning can be established only on the basis of generalizations from concrete samples of actually existing and efficiently functioning thinking, we have to start with an analysis of the most successful branch of modern thought, namely scientific reasoning. Even a brief survey of it indicates as its typical characteristics the following tendencies: an emphasis on continuity as contrasted with the principle of completely watertight compartments; relativity and interrelation as opposed to absolute, independent, eternal entities; evolution and dynamism versus static, unchangeable reality; pluralism of conceivable possibilities versus the exclusive, dogmatic assertion of a certain possibility as the only one conceivable.

These four tendencies can be in turn illustrated by (*a*) Maxwell's electro-magnetic theory of light, arranging in a continuum such seemingly different phenomena as sunlight, different colours, ultra-violet and infra-red rays, X-rays, and Hertzian waves; (*b*) the modern concept of species in biology or of elements in chemistry; (*c*) the modern theories regarding the evolution of the solar system, of our globe, and of the chemical elements and life on it; (*d*) the simultaneous existence of the geometries of Euclid, Lobachevsky, and Riemann.

These four tendencies are all closely interrelated, and each of them is actually an outgrowth of others, but from the methodological and logical points of view the emphasis on continuity is the most important A more detailed analysis of a single sample of modern reasoning, namely, of Dewey's *Interest and Effort*, reinforces the statement. We see that here all the problems involved are solved by consistent and thorough application of the same method—the establishment of continuity between contrasted concepts or competing hypotheses

Accepting this idea of continuity as the fundamental postulate and guiding principle, we apply it to an analysis of reasoning itself, and start by establishing continuity between different kinds of cognitive activities.

In the light of the continuity principle, it is easy to see that actually there are no sharp dividing-lines between perception and conception, subjective and objective, apprehension and comprehension, judgment and inference, deduction and induction, "intuition" and reflective thinking.

All these cognitive activities can be thought of as different forms of judgment, since they are all combinations of the same elements, only taken in different proportion. These elements can be represented by the following symbols. Po = previous experiences pertinent to the issue or problem, or uncertainty initiating the piece of reasoning in question, if these experiences are sufficiently organized around the problem. Pn = experiences of the same kind but not sufficiently organized in respect to the problem in question. Ni = new or present cognitive experience, in its elements identical to certain previous experiences. Nd = the elements of the new experience considerably different from previous experiences. R = the rate of the fusion of the Po and Ni + Nd. C = the degree of complexity of the cognitive unit in question. If we take A to represent any cognitive activity or any unit of thought, then this can be expressed by the following formula :

$$A = \frac{1}{R}\left[(Po + Pn) + (Ni + Nd)\right]^{c}.$$

If R is great, A will represent " intuition " , if R is quite small, A will be reflective thinking. If Pn + Nd > Po + Ni, the unit of thought will be induction , if Po + Ni > Pn + Nd, it will be deduction. If Ni + Nd > Po + Pn, the cognitive experience will be objective , the reverse relationship will stand for subjective experience, and so on.

This unified and quantitative conception of thought-processes is methodologically very helpful, since it will enable us to analyse them better and to make broad generalizations which can be applied, with certain modifications, to all kinds of cognitive activities Generalizations made in this way will constitute the principles of dynamic Logic.

The first principle—the Principle of Polarity—deals with a very familiar fact, that any cognitive activity is based on contrast and differentiation Without warmth we should not know what cold is, and where there are no competing hypotheses there is no reflective thinking. Generally, no unit of thought has any meaning without its opposite ; that is, units of thought always function in pairs, or, in other words, no A functions without its non-A.

The second principle—the Principle of the Partial

Functioning of Concepts—is concerned with another very important phase of reasoning—the technique of the merging of a new experience with previous experiences. Obviously, reasoning is essentially a union of a new experience with previous experiences which constitute the mind, but how this takes place is not quite clear. It is helpful to think of this process as if the new experience were entering the structure of the mind, being attracted by a pair of concepts or centres of crystallization which at any given moment determine the development of the reasoning process. Guided by the pair of opposites, the new experience eventually settles somewhere between the two poles at a distance from the poles inversely proportional to its likeness to each of them. Since any concept may form a pair of poles with an almost indefinite number of other concepts, it is obvious that any concept in any single case functions only in one of its possible aspects. Which aspect of a concept will function, is determined always by the other concept forming the pair. This is the essence of the Principle of the Partial Functioning of Concepts.

The next principle—the Principle of Continuity—deals with another important aspect of the reasoning process—with the growth and accumulation of knowledge. The accumulation of knowledge "along a certain line" is an arrangement of as many different experiences as possible between the two poles determining "the line" of knowledge in order of the degree of their likeness to the poles. It is very much like an arrangement of soldiers in a line in order of their heights. The smaller the intervals between the soldiers, the stronger the line. The closer the experiences are to one another in their continuum between the poles, the more thorough and better the knowledge. The expert on human intelligence must not only know that there are stupid people and clever people, but must also know all gradations of human dullness and brightness from idiots through the feeble-minded, morons, dull, average, bright, very bright, and exceptionally gifted, up to geniuses. When very many different members of a continuum are established between the poles and the difference between any two neighbouring terms is very small, then the degree of continuity reached is very high and it is almost impossible to see the qualitative difference between the terms of the continuum Each of them definitely bears characteristics of both the opposite poles, or, in technical terms, each A becomes both B and non-B. All this constitutes the Principle of Continuity, which runs · The essence of dynamic reasoning is the establishment of continuity between two opposite poles of a unit of thought, which tends to terminate in realization of their qualitative identity.

The fourth principle—the Principle of Quantitative Indices—deals with the organization, use, and especially communication of our cognitive experiences. · If we determine the field of our problem or the direction of the accumulation of knowledge by a pair of opposites ; if we further accept theoretically the continuity between the poles and actually construct the continuum between them , all this will not be enough for efficient social use of our knowledge If, for instance, we propound the question whether people are or are not responsible for their actions, and then accept that they are both responsible and not responsible, this will not help us much in understanding the problem of responsibility generally and in discriminating between different cases of the responsibility. We must know to what degree people are responsible and not responsible in each given case Generally speaking, to know that A is both B and non-B is not enough ; we have to know also to what degree it is B and to what degree non-B. And this is the essence of the Principle of Quantitative Indices : No statement has any definite meaning without a certain quantitative index.

These four principles, if taken as independent, static, and absolutistic statements, possess only descriptive value. But if taken in the spirit of continuity, relativity, and dynamism, they become normative. For instance, if we think of the idea of polarity as a continuum between very vague contrast and definitely stated, sharp opposition, or of the idea of continuity as a continuum between identity and separation, then each principle acquires its normative counterpart.

I. An A must never be used separately from its non-A.

II. The pairs which determine which aspect of a concept is put into operation must be explicitly expressed.

III. Efficient thinking must start with an assumption of continuity in potentiality and work for its actual realization.

IV. The quantitative value of any unit of thought must be explicitly indicated, preferably in terms of objective continuum-scales between the two poles of the opposites.

The practical value of these normative principles will doubtless be best understood by seeing in what the violation of each of them results.

The violation of the first principle leads to meaninglessness, for instance, to deprive egoism of its opposite, altruism, and say that all human actions are egoistic, practically robs the term egoism of all its meaning. To restore it, we are forced to introduce various modified egoisms opposed to each other—narrow and broad, social and anti-social, desirable and undesirable, and so on

Neglect of the second principle results in ambiguity, as may be illustrated by the use of the word "natural," which, if used by itself, may mean "in accordance with laws of nature" (opposed to supernatural), or "common" (opposed to unusual), or "simple" (opposed to fanciful), or "normal, proper" (opposed to perverse).

Unwillingness to follow the third principle results in a hopeless deadlock in reasoning or in argument. Arguments as to whether experience is an active or a passive affair, whether playing tennis is physical or mental activity, whether human beings are products of heredity or of environment, whether mathematics is a practical or a theoretical discipline, and so on, are obviously endless, unless the answer "both" is accepted.

Neglect of the fourth principle leads to utter confusion and inefficiency. Merely to say that carrying a piano, as well as memorizing a poem, was both physical and mental activity, without further modification, would not be very enlightening[1] To describe Socrates and a professional gambler as persons both honest and dishonest without any indication of the proportion of honesty and dishonesty in each case would hardly help to encourage honesty and combat dishonesty.

It is worth while to notice that the Dynamic Logic of Included Middle is not a flat repudiation of the Static Logic of Excluded Middle, nor a substitution for it of something entirely incompatible with it. In fact, Dynamic Logic is only a more inclusive system which contains Static Logic as a part of itself, since the cases where A is 99 9999..... per cent B and 0 000.....1 per cent non-B closely correspond to Static Logic In other words, Dynamic Logic is not absolutely relativistic, but relatively relativistic, and therefore highly consistent and comprehensive.

This hypothesis, like every fundamental issue, has many different aspects and correlated problems to be considered. Therefore, before the nature and principles of the new logic are discussed at length (Chapter V), certain introductory problems must be taken up. First we have to review and critically to evaluate certain preliminary assumptions underlying any practical reasoning and commonly used as criteria for accepting or rejecting statements (Chapter II). At the same time we shall see better the logical nature of the puzzling pieces of reasoning called sophisms, which will also bring some light on the problem of the difference between static and dynamic reasoning. Secondly, it must be made clear what is here understood by the term Logic and what is the relationship which it, Logic, bears to other disciplines (Chapter III). Then, since a special emphasis is put here on the descriptive aspect of Logic, the general cultural background of which the classical Logic was an outgrowth must be discussed, and finally also the modern reasoning on which the new Logic is to be based must be analysed (Chapters III and IV). This order of topics will be observed in the following presentation.

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[1] To have an idea how it can be done better, see the table on page 174.

CHAPTER II

SOPHISMS, PARADOXES, AND COMMON SENSE

Paradoxes of yesterday are truths of to-morrow
—E. R. de Laboulaye.

If the difference between classical and modern thinking is so fundamental and the discrepancy between the two ways of reasoning begins at the very starting-point, in the most primary assumptions, like "A is either B or non-B," it is quite obvious that all the tools of classical thinking, all its notions and propositions, cannot be accepted by modern thinking without a thorough examination and criticism. The situation is very much like the relationship of Euclidean geometry and that of Lobachevsky. Because the two geometries disagree on the fundamental axiom of parallel lines, all the other propositions of Euclidean geometry must be accepted or rejected by Lobachevsky's, not on the ground of their standing in the traditional system, but only on the ground of their agreement or disagreement with the chain of propositions of Lobachevsky's whole system. If the statements of classical logic are directly or indirectly based on the Law "A is either B or non-B," rejected by the new logic, then all of them automatically, so to speak, are out of tune with the new logic and by themselves are not in the least authoritative nor acceptable to it. Being generally not authoritative for the new logic, the standards of traditional thinking certainly cannot be used as a criterion for accepting and especially for rejecting any statement, when the new reasoning is presented or discussed.

This assumption in a general form may already look quite legitimate and reasonable, but in order to see its full practical importance it is necessary to review certain specific forms of device for rejecting unacceptable notions, which are generally much in use and will probably be used against the new reasoning. Among the devices easiest to use in attack and hardest to parry is that of calling the unacceptable statements sophisms or paradoxes or claiming that they are contrary to common sense.

Generally speaking, the strongest point of the method of attack is that usually no specific reasons are given for rejecting the statements in question. In the best cases it is argued that the proposition directly contradicts the most fundamental, indisputable axioms of human reasoning. But in the discussion of the new logic, the strength of this argument turns out to be exactly its weakest point, because the new reasoning already starts with the hypothesis that the traditional fundamental laws of thought are not only disputable but wrong. In order to realize distinctly that it is not enough to classify something as a sophism or paradox in order to disqualify it, it will be of great help to see what, after all, are the so-called sophisms, paradoxes, and "common sense" arguments.

First of all, what is here meant by a sophism? In modern works on logic there is a definite tendency completely to identify sophisms with fallacies, and often to drop out the term sophism altogether. But in non-technical writings and in everyday speech generally, one may see a rather pronounced difference between the notions of mere fallacies and sophisms. As the dictionary definitions show, two elements are inherent in sophisms: (*a*) a conscious and even deliberate attempt to twist the truth, and (*b*) a high degree of apparent correctness of reasoning.[1]

The former element, being entirely psychological, has very little interest for Logic proper; it explains only the attitude towards a certain piece of reasoning, and does not bring any light on the technique of reasoning involved. But the latter element, the special difficulty in discovering any mistake in reasoning which contradicts all experience, cannot be neglected without loss in exactness of definition and failure to distinguish and register a mode of human reasoning quite specific and significant-in-itself. Most of the fallacies: *petitio principii*, *ignoratio elenchi*, *post hoc—propter hoc*, etc., are well-formulated false procedures, definitely contradictory to certain logical canons, and, if any concrete case of the fallacies is presented, it is possible to classify it fairly precisely and to show clearly why it is classified in that particular way. But, besides these, there are peculiar examples or models of reasoning which are either clearly contradictory to all our experience or obviously tricky, but nevertheless cannot be classified as a particular case of a certain definitely illegitimate logical procedure. Often, indeed, the mistake itself can hardly be found out or located. These peculiar whims of human reasoning are what is here meant by the term sophism. To be quite specific, the sophisms which are important from the standpoint of the discussion of the new logic may be enumerated at once. They are Zeno's arrow, Achilles and the tortoise, the beard or heap sophism, and the impossibility-of-learning sophism.

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[1] Webster's *Dictionary* defines sophism as "an argument esp. a formal one intended to deceive; also an argument embodying a subtle fallacy, but not intended to deceive." Chambers's *Twentieth Century Dictionary* regards it as "a specious fallacy."

The life-career of the sophisms is extremely instructive, and even dramatic. They are very old, nearly as old as human thought itself, at least as European thought, in an organized and self-conscious state. But, though so old, they have even now more than an archaeological interest. Through all the centuries, they have not worn themselves out, but, on the contrary, have been an undying challenge to human intelligence and wits, which is not satisfactorily answered at this day. Zeno's sophism was one of the greatest philosophical issues of his time, and divided the best minds into believers in the possibility of motion and philosophers who thought that it was impossible, being incomprehensible to the human mind.

There is something really charming and even refreshing in the firm, unsophisticated faith in the power of human reasoning exhibited by the first promoters of the sophisms! It looks so odd, especially to us who live in an essentially positivistic age, when nearly every broad inquiry starts with doubt of everything. To refuse to accept "facts" as contradicting Logic! To us it seems almost incredible, but that the situation was not so simple as it appeared at first sight was quite well pointed out by the great Pushkin in his short poem *Motion*.

MOTION

A sage once said there was no motion here
Another walked, making no more reply.
Which answer, as a witty one, was lauded
But later, I recall another case
Daily the sun creeps westward through the sky.
Yet was old, stubborn Galileo not right?[1]

On the other hand, about twenty-five centuries after Zeno, one of the most up-to-date philosophers of our time, Bergson, discusses the other form of the same sophism, "Achilles and the tortoise," shows that previous explanations miss the point, and presents his own new solution of the ancient puzzle.[2] This alone presents enough evidence that sophisms, in spite of their age, have not lost their interest and vigour, but a more detailed analysis of them will prove it more definitely

The situations and objects discussed in the sophisms are quite unlike each other and look as if they would have nothing in common—a flying arrow, a beard, the impossibility of learning, a race between a fast runner and a tortoise These are wholly unconnected ideas, but, contrary to their appearance, all the sophisms are very similar in their logical nature. They all deal with the problem of continuous change.

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[1] The English version by Edgar de Evia

[2] H Bergson, *Time and Free Will*, London and New York, 1912, p. 113 f.

Zeno's arrow sophism presents the simplest and most elementary form of the problem—continuous change of position in space, that is, motion. He tries to prove its impossibility by reasoning something like this: If an arrow really moves, it is something which exists. Everything existing exists in Time and Space. If this is so, the arrow in any definite given moment of Time is in a certain definite position in Space; but if this is so, the arrow must actually remain still, not moving, and thus its motion is generally impossible. The chain of reasoning looks quite correct, logical, and convincing. What makes it worse is that in fact it is correct from the point of view of classical logic. The flaw or mistake in the reasoning is the hidden assumption that at one and the same time any body may be in only one place. That is the specific form in which the general "law of thought," "A is either B or non-B," manifests itself in this case. But take for granted the opposite assumption that "any body may be at one and the same time in many places," which would be an equivalent to the situation of the general law "A is both B and non-B," and the puzzling sophism ceases to be a "specious fallacy" leading to absurd conclusions, and becomes quite an acceptable piece of reasoning, such as this: "The arrow does exist; it can be in many places in space at the same time, and consequently it can move." As may now be seen, what gave the sophism a bad connotation was only its one hundred per cent loyalty to traditional Logic.

The "beard" sophism faces the same problem of continuous change, not now in position in space but in a process, *i.e.*, any happening in our environment with possible increases and decreases in its intensity or rate. As an example of such a process, a beard is chosen. The reasoning runs as follows: Somebody is asked whether one hair constitutes a beard or not. The answer being "No," he is asked again whether 300 hairs constitute a beard. The answer being "Yes," he is asked the same question about 2, 299, 3, 298, 4, 297, 5, 296, and so on, hairs, to which for a time he answers "No" and "Yes" in turn. But obviously a moment will eventually come when he will be driven to admit that of two collections of hair different only by one single hair, let us say 68 and 69, one, 69 hairs, would constitute a beard and the other, 68, would not. Then, after all this questioning, he is placed in the absurd position of having to give reasons why that 69th hair will at once make a beard from something which is not a beard, or why taking one hair from the bunch of 69 hairs on somebody's chin will cause it to cease to be a beard Here again the situation remains absurd so long as we cling to the law "A is B or non-B," which in our case makes the collection of hair to be either beard or not beard. But if we admit that some collections of hair, for instance, roughly speaking, between 40 and 100 hairs, are both beards and not beards, all element of absurdity disappears at once

The sophism which claims to prove that no learning is possible gives an illustration of the embarrassment created by traditional logic in passing judgment upon processes of the so-called inner or mental life. Dewey presents it in these words: "The Greeks acutely raised the question, How can we learn? For either we know what we are after, or else we do *not* know. In neither case is learning possible, in the first alternative because we know already; in the second, because we do not know what to look for, nor if, by chance, we find it, can we tell that it is what we were after."[1] Again, what makes the reasoning a sophism is the assumption that our state of mind must be either knowledge or not knowledge—B or non-B—and again all the confusion disappears when we admit that we can know and not know something at the same time.

Taken in a broad sense as symbols and generalizations, the three sophisms embrace practically the entire scope of all our possible experience: (1) the abstract, graphic equivalent of any conceivable change and of any experience (the motion problem), (2) changes in the outside world (the beard); and (3) changes related to ourselves (learning). In all three cases we come to absurd, unacceptable conclusions if we follow the static traditional logic. This simple fact, if thought over and appreciated at its full value, shows the tremendous significance and instructive importance of the sophisms. Incidentally, it is now possible, after having found the general elements among the sophisms and after having seen their likeness in logical procedure, to stop calling them generally sophisms, as opposed to other specified fallacies. They can now be considered as forming a new specific group of fallacies, which may be christened something like "unconditioned following of the fundamental laws of traditional Logic."

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[1] *Democracy and Education*, p 174.

It is true that, strictly speaking, from the standpoint of traditional Logic itself sophisms can hardly be classified as fallacies, and here emerges the dramatic aspect of the life-career of the sophisms For many centuries they were labelled by traditional Logic as "specious fallacies" or "fallacious arguments designed to deceive" and treated as something like outcasts or evil spirits of Logic, and, as a matter of fact, all this disgrace and the hard names came only because the sophisms were one hundred per cent loyal to the spirit and letter of traditional Logic and in a certain way were its most typical examples! On the other hand, the active part which the sophism played in the historical development of reasoning must not be overlooked When, after the contest between Heraclitus's dynamic "*πάντα ῥεῖ*" and Parmenides' static "What is, is," the former principle was defeated and Aristotle put humanity for centuries into the three-walled prison, very comfortable and wonderfully organized, but nevertheless a prison, of his Authority, Philosophy, and Logic, the sophisms, in the innermost stronghold of static Logic, by the very fact of their existence rebelliously proclaimed that the wonderful prison was not perfect in all respects and that beyond its walls there was Life, and Truth also. Like old, stubborn Galileo, they never ceased to shout into the face of the static philosophy of life, "Epur si muove!"

To call a statement a paradox, after labelling it a sophism, is usually the next step in the defence against an unacceptable proposition. The formal definition of a paradox usually reads something like this: "A statement seemingly absurd or self-contradictory in its terms, but really true." The definition presents the paradox as something exactly opposite to a sophism; the former is seemingly false but really true, and the latter apparently true but really false. The real truthfulness of a paradox, finally admitted, as would be expected, should make it a thoroughly reliable and highly valid statement, but as a matter of fact, in the process of reasoning or argument, paradoxes are never recognized as true statements of quite a good standing. They usually seem to lack in efficiency, in ability to carry on, in other words, in pragmatic value. A paradox is nearly always self-centred, and tends to remain in "splendid isolation" Nearly everybody has witnessed how, sometimes, an interesting statement is excluded from discussion by the remark, "Oh certainly, that is a brilliant paradox," or a clever argument disqualified by an answer, "Oh, you cannot prove anything to us by your paradoxes." On the other hand, however, the human mind loves and admires paradoxes. They possess a fascination and irresistible attraction for the mass of men as well as for individual geniuses The most common epithets for a paradox are "brilliant," "bold," "clever." In paradoxes there is always something audacious, lively, refreshing, inspiring, and entertaining. They stimulate thinking, point out new and unexpected possibilities of life and new avenues for thought. Many proverbs are in the form of paradox. "The shortest way there is the longest way round." Proudhon's paradox, "Property is theft," is often dangerously convincing. One of the greatest books ever written, Carlyle's *Sartor Resartus*, is a continuous paradox from beginning to end. Half of the captivating charm of Nietzsche's maxims is that they sound like paradoxes. Many sayings of Christ were paradoxes to his contemporaries. The most brilliant and entertaining modern English authors, who are also keen and penetrating dissectors of the intricacies of life, are probably Oscar Wilde, Bernard Shaw, and Chesterton. Subtract paradoxes from their writings and not very much will be left.

The double nature of paradoxes, their inefficiency in systematic reasoning or argument and their tremendous attractiveness to the human mind, may be understood better if the definition of paradox given above (as compared with sophism) is expressed in more definite, more explicit wording. A sophism, it was said, is reasoning apparently true, but really wrong. In a more explicit form it would read, "a reasoning in accordance with traditional logic, that is, with the law that 'A is either B or non-B,' but contradictory to experience." In the same way a paradox may be defined as reasoning apparently incorrect but really true, or "reasoning contradictory to traditional logic but confirmed by experience." In fact, paradoxes always contradict the law of static logic, "A is B or non-B," and are always an expression of the law of dynamic logic, "A is B and non-B simultaneously."

An analysis of any paradox would illustrate it. Somebody has coined this statement: "The most original people are frequently those who are able to borrow most freely." The first impression of the proposition, as of any paradox, is that something is the matter with it. In other words, that it contradicts something which we have been accustomed to consider true and right. In this case it is the idea that "by definition" an original person is somebody who creates and works out his own ideas by himself and independently. He does not imitate others, nor repeat the notions of other people. Without this definition, so familiar to us, our paradox would not be a paradox, but just a commonplace statement, a platitude. The conventional definition is certainly true and quite right, if (and this is a very important "if") only it is not understood in the spirit of static logic, as absolutely, one hundred per cent true, exclusive of all possible contradictory propositions. Indeed, it is obvious that nobody can have any ideas worked out exclusively by himself. In other words, a person without any chance to borrow ideas from others, and isolated completely from human society, would not be able to have any ideas at all, either borrowed or his own. In reality, such an extreme case certainly cannot occur, but the tendency in that direction may be often observed together with its very harmful consequences. E. Thorndike in his address on *Education for Initiative and Originality* condemns the tendency severely, and definitely backs our "paradox." Says he: "Originality in mathematics or salesmanship is consistent with the most complete conformity to social customs." "The truly independent mind does not make less use of other men's ideas than the servile thinker, but more." "For a man whose every thought was original we should have to go to our hospitals for the insane . . ."[1]

As far as such a one-sided understanding, in the spirit of the above definition, of the notion of originality exists and influences our thinking, the need for and the function of the above-mentioned paradox is obvious. It goes to balance the situation, to emphasize the harmfulness of the static one-sided point of view, and reminds one of the truth of the contradictory statement. In other words, it goes to prove that A is not only and exclusively B but at the same time non-B also.

When Oscar Wilde drops an aphorism like "A mother who doesn't part with a daughter every season has no real affection,"[2] it looks like a paradox, only because we have got accustomed to thinking of affection as something which attracts us to the object of our affections. As long as we think of the attraction as something absolute, exclusive, incompatible with separation, we see in the aphorism a paradox, and thereby testify to its necessity for straightening up and balancing our reasoning. The fact that a paradox is always something counterbalancing some one-sided attitude, and therefore impossible without a contradictory statement tending to become exclusive, is seen best in the paradoxes where both statements are given, so that each of them looks like a paradox For example: "There is only one thing in the world worse than being talked about, and that is not being talked about;" or "In this world there are only two tragedies: one is not getting what one wants, and the other is getting it. The last is much the worst, the last is the real tragedy."[1]

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[1] E. Thorndike, *Education for Initiative and Originality*, New York, 1919, pp. 4, 6.

[2] *The Prose of Oscar Wilde*, Cosmopolitan Book Corporation, New York, 1916, p. 668.

To sum up: paradoxes in their logical nature are a realization in practice of the reasoning based on the law "A is B and non-B," and that is what makes them so fascinating and explains why the human mind responds to them in such a definite, emphatic way. We, without complete realization of their logical mission, distinctly feel that they are something new, creative, badly needed, and very promising. The reason why paradoxes, on the other hand, like gorgeous double flowers, are often somewhat sterile and inefficient, lies in the fact that, being reasoning in the right spirit and correct direction, they lack organized method and definite rules of the standardized procedure of reasoning in accordance with the new spirit. They are very much like a highly gifted, ingenious pianist who possesses but very poor technique and sometimes, in spots, gives most enjoyable moments, most wonderful interpretations, but in the long run and in the general development of the art of piano-playing is of little significance and influence, being handicapped, isolated by his poor technique. The same may be said of paradoxes. Poor technique and lack of organized canons of the new logic make them more interesting than workable. Assuming quite soundly that A is B and non-B, they fail to indicate to what degree A is B and to what degree it is non-B, and the lack of that quantitative index makes them of little value pragmatically.

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[1] Oscar Wilde, *op cit*, pp 606, 631

It was mentioned above that first to label it sophism and then to label it paradox are very often two consecutive stages in the defence against an undesirable proposition. But the first step in the defence is usually the appeal to common sense. A good illustration of this would be the discussion which often follows an attempt to present to some conservative mind certain points of Einstein's theories, such as curvature of space or decrease in mass with increased speed. The first reaction frequently is: "All this is positively absurd, as is obvious to anybody who has not yet entirely lost his common sense" If this line of defence is broken, the new one sounds something like this: "That is just a clever sophism, one of the many mathematical sophisms by which you can prove that two is equal to five, or something even more absurd" If it is made clear that there is no reason to consider the proposition a sophism, the last resort is the statement: "All right, after all, all this is only a wild paradox which proves nothing"

But the first step of all is usually the appeal to "common sense," and it really is a tremendously powerful, though not very practical, defence It is something like the German "Big Bertha" If the projectile hits its goal, everything at that spot is destroyed completely and for ever. But if, as in most cases, the shell lands far away from its target, the whole proceeding is only a waste of time and energy.

The meaning of common sense is very broad, or, rather, it is a conglomeration of several notions. From a practical point of view there are three main meanings for "common sense." (1) The power of non-rational, intuitive, prelogical judgment, as, for instance, when people reject something without further explanation as contrary to common sense. Although this argument may be of tremendous individual import to the person guided by it, nevertheless it has no social value. If its authority is accepted, it has an irresistible power in a discussion, but if questioned, it fails completely because, in the same intuitive way, it may legitimately be entirely neglected without any reasons given. (2) Almost the same meaning of "common sense" may be given, but in more explicit, more articulate form, as something contradicting the fundamental laws of thought. For instance, most people would say that a statement like "Snow is white and black" is contradictory to common sense, and, when asked why, they would answer: "Because white and black are two opposite ideas, and nothing can be black and white at the same time." In this case, rejection of the statement is not just intuitive, as previously mentioned. Formally it is logical, in the sense that it is based on an appeal to a broader generalization, but as a matter of fact, being a direct appeal to the general principle accepted intuitively, it is also considerably extra-logical and is binding only if the fundamental laws are accepted. For dynamic Logic, which starts with challenging the laws of thought, the contradiction to "common sense" in that sense is neither unexpected nor alarming. (3) Sometimes the notion of "common sense" has a quite different meaning, very close to the power of practical judgment, discretion, prudence. Very many teachers have received instructions from their superiors something like this: "You have to maintain a reasonable amount of discipline in your class You may use punishment if needed, but not too much We have no detailed regulations. Use your common sense." The essence of this meaning of "common sense" is an emphasis on the quantitative or modifying aspect of reasoning, a request for some quantitative index in judgment, and from that point of view it is of a very great importance. In its intent, the attempt to introduce a quantitative factor into judgment suggests the most important issue of modern logic. But, its realization, being entirely intuitive, personal, does not possess any objective social value. It cannot be discussed. Teachers who have been told to use their common sense have not really received any instructions, any help whatever, and in a concrete case it would be impossible to discuss with any certainty whether "common sense" was used properly or even used at all. Thus even this last meaning of common sense, in spite of its extraordinary significance and value as a challenge, cannot be a criterion for the validity of any judgment or statement, again because of its illogical, intuitive nature

The quantitative aspect of thinking also suggests two other objections, fairly often put forth in the course of argument, which are worth mentioning They approach the problem from two opposite points of view, and both are invalidated if taken in general form because of their indefiniteness and subjectivity. They are the charges of hair-splitting and of reasoning by analogy The charge of "hair-splitting" protests against a too thorough and exaggerated preciseness. It is obvious that there is nothing intrinsically wrong in preciseness. The protest may be based only on practical grounds, pointing to the waste of time and energy in indulging in unnecessary niceties But what is really "unnecessary"? The criteria of it are only the practical consequences of the procedure in question. Discrepancy in a quarter of a pound in determining the mass of the sun is of no importance, in a Delicatessen-store a quarter of a pound cannot be so neglected, a mistake of much less than a quarter of a pound made by a druggist in a prescription may be practically a crime. The validity of the "hair-splitting" charge must be specifically proved in any concrete case. In discussions on Dynamic Logic there is little danger of hair-splitting. Looseness and laxity in thinking are exactly the points which Dynamic Logic seeks to eradicate, but they are so strong and so firmly entrenched that they easily counteract any possible "over-preciseness."

The charge of reasoning by analogy, quite opposite to that of hair-splitting, attacks looseness and vagueness in thinking. Again, the charge in a general form does not possess definite meaning. As a matter of fact, all reasoning is to a lesser or greater degree reasoning by analogy. There is nothing in the world absolutely identical with something else. If two events were really absolutely identical we should not be able to distinguish them, and they would look to us like one and the same thing. Nothing is identical even with itself; a nail, a second ago, is not identical with the nail at present, because its spatial and temporal co-ordinates have been changing all the time, to say nothing of changes in its mass, constitution, and electric, thermal, and chemical characteristics. In the main business of reasoning, in the establishment of relationship between a present and a previous experience, the relationship is based not on any absolute identity of different elements of experiences, but on the partial similarity of them. By abstraction we neglect differences and make use of similar elements, that is, we reason by analogy. The more likeness we have, the better probably, from a certain point of view, is the reasoning. But whether the like elements are sufficient or are not sufficient to constitute valid reasoning, only a practical test of the reliability of the propositions in question can show

Any new and broad generalization especially risks meeting the accusation of reasoning by analogy, because, merely in consequence of its novelty, its reliability has not yet been tested by experience. So, in a discussion on the new logic, charges of "thinking by analogy," if presented in a general form, cannot be accepted as valid. The charges may be considered valid only if specified and reinforced by proved inefficiancy, unworkability, of the propositions challenged.

To conclude this review of different logical devices frequently used in defence against some proposition which we are inclined to reject, it seems safe to say, that in a discussion on dynamic logic the mere classification of any proposition as a "sophism" or "paradox" or "contrary to common sense," and so on, does not deprive it of its validity, because actually it means either (1) that the proposition in question is rejected intuitively, that is, without giving reasons for it, in other words that the objection is extralogical and consequently without authority outside the mentality advancing it; or (2) that the proposition is contradictory to the "fundamental laws of thought" of traditional Logic, which argument certainly cannot be sound for dynamic logic, which rejects the laws themselves; or (3) that the proposition may be either true or false in accordance with the value of a certain quantitative factor which is not given in sufficiently definite form to permit a conclusion to be reached.

CHAPTER III

WHAT IS LOGIC?

The use of the word logic is almost the only thing which logicians have in common; if we venture a step beyond that, and ask for definition of what is implied in it, we are instantly stunned with a thousand discordant voices from all parts of the world.—ROBERT BLAKEY

ONE of the most astonishing facts in the history of human culture is the almost complete lack of growth and development in *Logic* as compared with other sciences and arts. This little illustration will make it quite explicit: any modern textbook of chemistry or biology or psychology must be revised at least every five or ten years in order to keep up with the development of Science, but an average textbook in Logic in its first part—deductive Logic—usually retells what was formulated several centuries ago by Aristotle or by one of his mediæval disciples; while its second part, inductive Logic, presents what was introduced about seventy-five years ago by John Stuart Mill. Certainly in wording, in presentation, in illustration, something new and more modern is often introduced; but in essence nothing can be found beyond the generalizations of Aristotle and John Stuart Mill. It looks as if Logic were the creation of these two men only, and only twice in human history something essentially important and new had been contributed to the science of reasoning. On the other hand, after looking through books on the history of Logic, one finds that certain of them are rather bulky, and that nearly every philosopher has had something to say about Logic and has even tried to reconstruct it from his particular point of view. Furthermore, on the shelves of any good philosophical library scores of different "Logics" by different authors may be found, and it seems more than improbable that all of them would be merely repetitions of the others. How did two such mutually contradictory facts, the lack of growth in Logic and the abundance of logical writings, come to be?

This apparent contradiction may be best explained by discussing first, what, after all, Logic is. What is the meaning of the word? Professor Baldwin begins his voluminous *Genetic Logic* with the words "The term logic has been variously used and variously abused," and this statement is really a very good introduction to any review of the meaning of Logic.

Let us take at random a few definitions of Logic given in different logical writings: "Logic . . . may be considered as the Science and also as the Art of Reasoning" (Archbishop Whateley)[1] "Logic may be briefly described as a body of doctrines and rules having reference to Truth" (Bain)[2]. "Logic is the art directing reason aright in obtaining the knowledge of things, for the instruction both of ourselves and others" (*Port Royal Logic*)[3] "Logic is the science of proof or evidence" (Bode).[4] "The science of logic is the systematic display or exhibition of the intellectual processes involved in one's own thinking. Logic attempts to discover the structure of the whole system of knowledge" (D Robinson).[5] "Logic is the science of pure concept" (Croce).[6] "Logical science is an unprejudiced study of the forms of knowledge in their development, their interconnection, and their comparative value as embodiments of truth . . . Logic has no criterion of truth, nor test of reasoning. Truth is individual, and no general principle, no abstract reflection can be adequate to the content of what is individual" (Bosanquet).[1] "Logic is the science of the operations of the understanding which are subservient to the estimation of evidence, both the process itself of proceeding from known truth to unknown and all intellectual operations auxiliary to this" (John Stuart Mill).[2] "Genetic logic has three lines of inquiry: (1) How thinking goes on? (2) What thinking is for? (3) What we think about?" (Baldwin)[3] "Logic is the science of the pure Idea. Logic therefore coincides with Metaphysics, the science of things set and held in thoughts . . Truth is the object of Logic" (Hegel).[4] "Logic is (a) a study of the relation of thought to human knowledge, (b) a science of the methods of correct thinking; (c) a study of scientific method; (d) a study of the methods of human knowledge; (e) the science of meaning; (f) a study of the methods of correct thinking and of the principles on which these methods are based" (Davies)[5]

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[1] Richard Whateley, Archbishop of Dublin, *Elements of Logic*, New York, 1858, p 29

[2] Alexander Bain, *Logic, Deductive and Inductive*, New York, 1889, p 1.

[3] *Port Royal Logic* (1662), Mr Baynes's translation (1850), quoted from *Historical Sketch of Logic*, by Robert Blakey, London, 1851, p 254

[4] B H Bode, *An Outline of Logic*, New York, 1910, p 4

[5] D Robinson, *The Principles of Reasoning*, New York, 1924, p 3

[6] B. Croce, *Logic as the Science of the Pure Concept*, London, 1917, title and p. 18.

Confronted with such a variety of definitions, ranging from the "science of the pure Idea" to the study of "what we think about" and so embracing nearly everything, one cannot but admit that Baldwin was quite right in saying that the term Logic has been indeed "variously used," and if it has been so variously used, certainly it has been variously misused and abused.[6]

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[1] B Bosanquet, *Logic*, Oxford, 1888, pp v, 3

[2] John Stuart Mill, *A System of Logic*, London, 1843, p 13

[3] J. Baldwin, *Thought and Things, or Genetic Logic*, London, 1906, p 16 f.

[4] W Wallace, *The Logic of Hegel*, Oxford, 1892, pp 30, 45, 31

[5] A Davies, *A Textbook of Logic*, Columbus, Ohio, 1915, pp 18–22

[6] Robert Blakey also wrote quite pathetically on the situation "What can present a greater anomaly to the understanding than that logic . should not be able to furnish two logicians of any country, who can agree in any one common principle of this science, nor be able to state to what particular or general uses it can be applied. . . The use of the word logic is almost the only thing which disputants have in common if we venture a step beyond this, and ask for a definition of what is implied in it, we are instantly stunned with a thousand discordant voices from all parts of the world" (*Historical Sketch of Logic*, Edinburgh, 1851, pp xvii–xviii).

But then the question arises, which notions of Logic are correct and which are "abused." In other words, what is the best, most correct definition of Logic? The difficulty in answering the question is much augmented by the fact that any definition is "the expression of volition, not of a proposition," as Bertrand Russell and Whitehead put it in their *Principia Mathematica*,[1] and therefore it can be neither "true" nor "false." From that point of view, since volition is not limited by definite laws, any definition by virtue of its being stated acquires a right to existence. It has its own indisputable significance, though this may be perhaps quite subjective and limited, and therefore it is correct. In this sense, no definition can be rejected as wrong. But, on the other hand, a definition may be judged on the basis of its pragmatic worth—how it works, how well it performs its function, or, to use Aristotle's terminology, how high is its "excellence." This criterion is more tangible, more practical, and we shall try to apply it in the search for the best definition of Logic.

The function of a definition is to express and emphasize the specific, particular intrinsic features of a notion or event in such a way that they cannot be confused or interchanged. If the main business of definition is to show the border-line between the notion in question and what is outside it, then the first step in getting a definition of Logic is to investigate the regions of human experience surrounding it.

That Logic lies within the field of cognitive experience is obvious and is not challenged by anybody. All our knowledge is, generally speaking, a resultant of two factors: certain happenings and corresponding attitudes or reactions of our mind or, more generally, certain corresponding processes in our mind. It is convenient in discussing Logic to call the two factors respectively "facts" and "statements of facts." The term "statement" emphasizes the two characteristic aspects of cognitive activities with which Logic deals: (1) a certain degree of organization of them; and (2) their social significance or communicability. It is true that from a certain point of view the contrasting of facts and statements may be challenged and even proved to be wrong. Indeed, are not our statements, as far as they have been made (and we can consider only really existing statements), real happenings and facts within our universe? On the other hand, are not all so-called facts as we know them merely complexes of our reactions, merely different mental processes, or, in the language of Hume, "impressions" of certain Kantian *Dinge an sich* which (if they exist) can never be known by our intellect, and therefore are outside our "Universe of discourse"? It is true that it is impossible to draw a distinct border-line between facts and statements, and that everything knowable is both fact and statement; but, on the other hand, in most cases the elements either of fact or of statement definitely predominate and usually it is not very difficult to see the difference between them. For instance, there is a difference between the fact that my room is on fire and the statement that my room is on fire, at least in the sense that the former destroys my books and furniture and the latter does not. The terms "facts" and "statements" are, therefore, very convenient for an analytic description of the different regions of cognitive experience and for a proper location of Logic among them

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[1] A. N. Whitehead and B. Russell, *Principia Mathematica*, Cambridge, 910, vol. I p. 11.

The following distinctions will also be of help for the purpose. (1) Any cognitive experience in its subject-matter may be predominantly concerned with inter-relations of facts and facts, or of facts and statements, or of statements and statements. (2) In their scope our generalizations and knowledge may deal with a relatively small, limited group of situations and possess a rather small degree of abstraction, or may deal with very large, unlimited series of situations and possess a very high degree of abstraction. The former will be called knowledge in the relative plane (limited generalizations), the latter knowledge in the absolute plane *sub specie æternitatis* (universal generalizations) (3) In their attitude, cognitive experiences may be purely contemplative, descriptive, or they may take into account the possible control of environment and be pragmatic, normative. On the basis of these distinctions, the classification of different types of cognitive activities may be presented in the following table:

	ABSOLUTE PLANE	RELATIVE PLANE
	Facts ⇄	*Facts*
Descriptive attitude	1 Metaphysics, Ontology	2 Sciences
Normative attitude	3 Ethics, Æsthetics	4 Engineering[1]
	Facts ⇄	*Statements*
Descriptive	5 Theory of knowledge	6 Psychology
Normative	7 Epistemology, Doctrines of Truth	8 Scientific Methodology
	Statements ⇄	*Statements*
Descriptive	9 Metaphysical speculations on the nature of reason, of judgment, concept, etc. Theoretical Logic	10 Psychology
Normative	11 Doctrines of Truth Dialectics Calculus of thought Symbolic Logic	12 Logic proper or Applied Logic

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[1] Engineering is taken here in a very broad sense. Something like it is defined in the preamble of the Constitution (1920) of The Federated American Engineering Societies: "Engineering is the science of controlling the forces and of utilising the materials of nature for the benefit of man, and the art of organising and of directing human activities in connexion therewith."

To be sure, the border-lines exist only in our table. In reality, it is impossible to make such a definite division, and nearly all the sections pass quite continuously each one into its neighbour; nevertheless, the divisions, considered as types and centres of crystallization of certain tendencies, are very helpful in forming a definition of Logic. It may be given in terms of the table in the following words: "LOGIC IS A COMPLEX OF RELATIVE AND LIMITED (AS CONTRASTED WITH ABSOLUTE AND UNIVERSAL) GENERALIZATIONS ON INTERRELATIONSHIP OF STATEMENTS HELPFUL FOR THE MOST EFFICIENT, PRODUCTIVE, AND EXCELLENT USE OF THE STATEMENTS."

This definition may be recognized as acceptable on the basis of its efficiency or Aristotelian "excellence," for it ascribes to Logic a content which cannot easily be attributed to any other division of cognitive experience, and which, on the other hand, cannot be taken away from the concept without making it empty and meaningless. But if not accepted on these grounds, then it remains valid on the basis of the volitional nature of the definition mentioned above, and shows in what sense the notion of Logic is used in this discussion.

Among the definitions listed above that of Davies comes closest to the one given here: "Logic is a study of the methods of correct thinking and of the principles on which these methods are based." This definition is good in the sense that it does not directly introduce much of what does not belong to Logic, but, on the other hand, it is so formal, almost verbal, that it, too, does not tell very much of what Logic really is. To make it a real definition one has first to define further the term "correct." The "correctness" of thinking is in a certain sense a tremendous problem in itself. It may be considered to be almost a complete summary of all philosophical problems together. Thus, if not carefully limited, that little word "correct" may introduce everything into Logic. From the point of view of this discussion, "correct" here would mean efficient or helpful in making any argument shorter, more fruitful, more definite as to conclusions, and of more use for the better control of the environment. This spirit of the interpretation of the word "correct" must always be taken as a basis in order to understand properly the last part of the definition, "the principles on which these methods are based," for otherwise almost any philosophical speculation may be introduced as one of the principles. The principles discussed and referred to must be definitely only the principles which actually contribute something to making thinking more efficient and more helpful in solving the problems of life.

Going back to the definition given in the terms of the above table, it is worth while to notice that if any need of interpretation and consequently a danger of misinterpretation, and especially of excessive broadening of the terms "efficient, productive, and excellent" arises, the terms must be understood as the term "correct" was interpreted above, that is, from the point of view of better control of environment.

The definition of Logic leads now to an explanation of the contradiction between the existence of the large mass of logical writings and the lack of growth in Logic. Most writings on Logic have been almost exclusively in the field of Sections 9 and 11; recently Section 10 has attracted much attention, but almost nothing has been contributed to the problems of Section 12. The predominance of metaphysical speculation has been so definite that P. Hermant and A. Van de Weale in their *Principales Théories de la logique contemporaine* use the following titles for chapters in their book: "Réalisme naif," "Réalisme transcendental," "L'Empiriocriticisme," "Réalisme," "Idéalisme," "Pragmatisme," "L'École néoscholastique," etc.[1]

Epistemological speculations may be very interesting, beautiful, and highly valuable by themselves, but obviously they have very little connexion with the practical problems of Logic. Strictly speaking, indeed, they can be called "logical theories" only by courtesy. The main function of any theory is to provide for the efficient manipulation of facts and situations about which one theorizes. For instance, nobody can handle chemical problems efficiently without knowledge of the atomic theory, or the theory of ionization, or any other fundamental chemical theory. But in the case of Logic, this function of theory has been almost completely lost. The very fact that many "theories" of Logic exist simultaneously, already looks suspicious, and indeed, if one finds a very efficient, convincing and well-organized piece of reasoning, one could never infer or even guess whether the author was a devotee of Realism or Neo-Scholasticism or Pragmatism, or whatever it might be. Even the staunchest and most zealous champions of a philosophical school would hardly insist seriously that the technique of thinking is best, for instance, among idealists, or neo-Kantians, or empirio-criticists, or others. They might say that vision, understanding, the closest possible approximation to truth, or even Truth itself is found exclusively in the teaching and philosophy of one particular school. But they would hardly venture to say that when facing a certain technical problem of reasoning, a very complicated relationship of statements, hard to grasp and check, in business, biology, sociology, and the like, one ought to seek help and guidance especially from a logician of the evolutionistic, the rationalistic, or some other particular school. None of them can be of any special help in the technique of reasoning.

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[1] Hermant and A. Van de Weale, *Les Principales Théories de la logique contemporaine*, Paris, 1909

Besides, theoretical discussions on the nature of judgment, reason, and the like, though probably of great value to those who put them forth and accept them, nevertheless have very little social value in the sense that they possess no convincing force, or very little, and cannot become a common possession of any large group taken at random. This is well expressed by the fact that the doctrines of theoretical Logic cannot be taught, as, for instance, trigonometry, astronomy, sociology, or engineering can be taught, they can only be presented for consideration and subjective choice in accordance with one's personal likes and dislikes. This fact, together with the separation of theory and practice mentioned above, is responsible for the lack of cumulative growth in theoretical Logic, resulting in a tendency to return again and again to the same theoretical problems without any help to or advancement of the technique of reasoning. All this explains the puzzling apparent contradiction between the amount of writings on Logic and the nearly complete lack of progress in teachable and practical Logic as the science and art of correct and efficient thinking.

The situation in Logic may be looked at also from a different point of view. What happens here reminds one of certain periods in the development of art when, in interpreting works of art, criticism has overwhelmed creative activity. Very often such one-sided flourishing of theory and criticism justifies the cynical saying that a critic is an artist who has failed. Very probably the fact that speculation about thinking has outweighed the practical achievements of Logic is mainly due to failure adequately to face the problems in the field of the technique of thinking. Indeed, there are too many indications that "something is rotten in the state of Denmark." The helplessness of Logic in making our debates and reasoning more definite, mentioned in the beginning of this discussion, the lack of interest in and respect for Logic as a school subject, the little difference, if any, in thinking efficiency between average persons who have studied Logic and those who have not, the severe criticism of formal Logic among even logicians themselves, the abundance of different competing "schools" of Logic—all these factors show that Logic as a pragmatic discipline indeed lacks creative impulse and sufficient ability for growth.

From the controlling point of view it is not important to establish definitely whether the impotence of theory has been a cause and the inefficiency of technique a result or vice versa; as a matter of fact, surely both have played their part, only we do not know their relative proportion. The main problem remains the same: what can be expected of the future? How can Logic be led out of the blind alley in which it now is?

It is very improbable that change will come forth as a *Deus ex machina* from within Logic itself. Systems of ideas, like systems of forces in mechanics, if closed, can not by themselves change their own movement. The changing impulse must come from without. But from where? If we go back to the chart on page 41, it is only natural to expect the inspiration and fertilizing influence to come from the neighbouring regions of experience. But closer investigation will show that the expectation can hardly be realized. Section 10, the psychology of reasoning, in a certain sense is very close to Logic and presents plenty of material very useful to the logician. In the last decades there has been a pronounced tendency on the part of logicians to use the material freely and even almost to fuse Logic and the psychology of reasoning together in *one* unit. One may cite, for example, Dewey's *How We Think*,[1] which in title and to a large degree in presentation is thoroughly psychological and descriptive, but is so extensively read largely because of its great help to our effort to improve our thinking, and to find out how we should and should not think. But in spite of the great light and the broadened outlook brought by psychology into logical problems, the fundamental difference between psychology, which is interested in the description of the process of thinking, and Logic, which is concerned primarily with the evaluation of the products of thinking, will always make them rather independent disciplines, and it is not from psychology that Logic can obtain the clues needed for the solution of its most intricate and fundamental problems. To be sure, psychology may be of very great importance to Logic in the process of its reconstruction, as will be later discussed in detail, but the guiding principle, the initial push towards reconstruction must be found somewhere else.

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[1] John Dewey, *How We Think*, New York, 1910

Section 9, Theoretical Logic, as the experience of centuries has demonstrated, is positively powerless to revive slumbering practical Logic and pour new blood into its veins.

The next Section, No. 11, is quite practical and active in its intent, but its doctrines try to find absolute, universal values and methods, try to embrace and comprise everything, and in this way they actually destroy their own purpose, and lose all practical value. The question "What is truth?" is now in the same position as when it was put by Pilate nearly two thousand years ago—unanswered. The dialectics of Plato, Kant, Hegel, to mention the most finished and typical systems, again being normative and to a certain degree logical in their purpose, are so much permeated by idealistic notions of Ideas, Transcendent Principles, the Absolute, and the like, that they become tools good only for metaphysical speculations, and not for the solution of the practical problems of the control of world of our experience. Hegelian ways of thinking, cleared of their metaphysical elements, were adopted by Karl Marx and Friedrich Engels and applied with some success to an analysis of social and economic problems. But even in this most practical form dialectics did become not a really logical tool, but rather a methodological device or, still more precisely, something like a supposedly universal law of nature—*ein Prinzip der Naturphilosophie*, but rather remote from the problems of Logic proper. Other forms of dialectics have been almost completely sterile outside metaphysics, and even among the Marxian socialists Hegelian dialectics are now considerably abandoned in favour of the empirio-criticism of Mach and Avenarius[1]

Calculus of thought or Symbolic Logic in its most advanced form, as it is presented by B. Russell and V Whitehead in *Principia Matematica*, is a remarkably well-organized and very beautiful doctrine Its part in the modern development of Logic will be discussed later in more detail, here it is enough to mention that it again has a very strong tendency to pursue the ultimate and final Truth Says B. Russell, "Pure logic and pure mathematics (which is the same thing), aims at being true in Leibnitzian phraseology in all possible worlds and not merely in this higgledy-piggledy job-lot of a world in which chance has imprisoned us"[2] Because of this, in the stage in which it now is, Symbolic Logic has hardly any practical value, especially from the point of view of dynamic reasoning Its formulæ are very wonderful, but so abstract that to insert into them data of experience or terms used in the discussion of practical problems outside mathematics appears to be a task nearly impossible.

All this shows that Logic cannot expect much help and inspiration from its near relatives. If this is so, where shall it look for help? The aspect of Logic emphasized by comparing it with grammar and the fact that actual thinking existed before Logic came into being, supply the answer. Logic has to forget for a while its normative function, and has to go back to study ways of actual successful thinking and to find the laws and canons thereof. In other words, modern Logic can be created only by generalization from the best examples of modern thinking. Certainly a thorough and detailed analysis, even of the leading examples of modern reasoning, would be a gigantic task far beyond the scope of this discussion.

[1] See, for instance, Berman, *Dialektika v svete sovremennoy teorii poznaniya*, Moscow, 1908

[2] B. Russell, *Introduction to Mathematical Philosophy*, London and New York, 1919, p. 192.

Probably, in spite of the tremendous interest of the work in itself, it would even be a waste of energy, since it would be a violation of the statistical principle, well expressed in the saying that "to know the vintage and quality of wine one need not drink the whole cask." For a general orientation, however, and for selecting the right samples for more detailed study, a brief account of the general trends and manners of modern reasoning may be of great help.

If one were to meditate on the progress of human thought during the last centuries and especially within the last decades, and to travel in imagination through different divisions of our knowledge, the following three cardinal ideas would appear as the most typical aspect of the modern mind. They are, indeed, more than mere cardinal ideas. They may also be thought of as the prevailing intellectual expectation, or the habitual approaches to any situation, or the most common attitudes, but, no matter how we were to conceive them, they would be, continuity as contrasted with the principle of water-tight and completely separated compartments; relativity and interrelation as opposed to absolute, independent, eternal entities, evolution versus static, unchangeable reality. These are all closely interconnected. Indeed, each contains in germ the two others, and all three are only different aspects of something broader and more general, which may be called dynamism as opposed to statics.

To the three characteristics of modern thinking a fourth, probably not so noticeable, may be added that is, pluralism of conceivable possibilities versus the exclusive, dogmatic, narrow assertion of a certain possibility as the one and only one. An illustration of the extreme form of this pluralism may be found in William James' philosophical "pluralism." More specific and more moderate forms of pluralism are presented by many modern mathematical conceptions. Throughout many centuries, for instance, mathematicians asserted as a definite fact, declaring it to be the only possibility, that through any point one line only could be drawn parallel to a given line. Then, in 1816, a Russian mathematician, Lobachevsky, took into serious consideration and thoroughly investigated the other possibility, namely, that through any point two lines could be drawn parallel to a given line Later a German, Riemann, considered a new possibility—that through no point could any line be drawn parallel to a given line. And now mathematicians deal with three geometries—one so-called Euclidean and two non-Euclidean.

Natural science presents another illustration in the concept of Man. Before the comparatively recent discoveries of the various remains of prehistoric man, only one kind of Man was known—simply Man But now anthropology talks about Java Man, Piltdown Man, Neanderthal Man, and so on. To us, who are accustomed to the idea of evolution, the change from Man to many different Men does not appear to be a great revolution in thinking, but it was when these concepts were first introduced How deeply all four characteristics penetrate our whole thinking may be made clear by illustrations from the different fields of science and social life.

Nearly any big division of *mathematics* in the essence of its method gives a good example of one or another of the four general principles Let us take, for instance, "The striking succession of generalizations by which the domain of the number concept, which once contained nothing but our familiar integers, has been gradually extended to embrace positive and negative, rational and irrational, real and imaginaries, cardinal and ordinal, including the transfinite numbers of Georg Cantor." [1] That the concept of Number is really fundamental in mathematics is quite obvious. But at first there was no one concept of Number, but only different numbers or, better put, different kinds of numbers, quite widely separated and even opposed to each other. Their names speak for themselves; irrational imaginary, surds (abbreviated from absurds) express, as definitely as can be, the idea of something quite different from "real" number. But to a modern mathematician the "unreal" numbers are "quite as genuine, quite as legitimate, as the ordinary integers and fractions."[1] The pigeon-holed entities have lost their separation and become one group, one concept, Number.

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[1] C. Keyser, *Mathematical Philosophy*, New York, 1922, p 413

The two pillar concepts of the whole edifice of mathematics, number and spatial relations, algebra and geometry, were fused by analytic geometry, that wonderful creation of Descartes's genius, into one powerful unit of geometrical analysis. At present they are so closely united that nearly all geometrical situations may be expressed by means of algebraic symbols and nearly all algebraic notions may be interpreted spatially. The differential and integral calculus of infinitesimals introduced by Leibniz and Newton, which, together with Descartes' analytical geometry, "may be regarded as the real beginning of modern mathematical science,"[2] is based essentially on the idea of continuity. Having established continuity between variables and their limits, between the elements of straight and curved lines, the calculus of infinitesimals has become an exceedingly efficient and representative method of mathematical thinking, in dealing with problems involving motion or constant variations.

The contrast between straight and curved lines, as well as between right and left, up and down, parallel and intersecting lines, is obliterated in another way by another branch of mathematics—projective geometry, a discipline of considerable practical value and of high theoretical interest, invented by Desargues (1593-1662) and then forgotten and lost until rediscovered and widely acclaimed by Poncelet in 1822. Keyser extols it as "perhaps the most beautiful branch of mathematics."[1] Projective geometry is based on these propositions:

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[1] Keyser, *op. cit.*, p. 409.

[2] Sedgwick and Tyler, *A Short History of Science*, New York, 1917, p. 274.

1. A straight line can be considered as produced to infinity, and then the two opposite extremities are united.
2. Parallel lines are lines meeting at infinity, and conversely.
3. A straight line and a circle are two varieties of the same species.[2]

To a layman these propositions sound very pluralistic. From the point of view of the discussion it is also worth while to notice that, as is said in the Report of the Institut de France prefixed to his *Traité des propriétés projectives des figures* (1822), Poncelet employed "ce qu'il appelle le principe de continuité"—what he calls the principle of continuity.

The concept of infinity mentioned above, which so revolutionized our conventional ideas of straight, parallel, and circular lines and nearly destroyed them, is of great interest and import in itself. Prof. Keyser says of it: "Among the great mathematical concepts that are accessible to laymen there is none which surpassed this one in importance or in power."[3] The modern definition of infinity presents a good specimen of the fourth above-mentioned tendency of modern thinking, towards the pluralism of possibilities versus exclusive dogmatism. It reads as follows: "An assemblage (ensemble, collection, group, manifold) of elements (things, no matter what) is infinite or finite, according as it has or has not a *part* to which the whole is just equivalent, in the sense that between the elements composing that part and those composing the whole there subsists a unique and reciprocal (one-to-one) correspondence."[4] It sounds a little paradoxical, and it is not always easy to accept it. To bring it home more and to make one realize that it is not merely a clever "sophism" or metaphysical nicety, the following simple illustration may be of help. If we take a row of numbers, 1, 2, 3, 4, 5, 6, 7, . . . (I), it is quite obvious that their number will be infinite. If we multiply each of them by 2, it is obvious again that the number of the products will be exactly the same as the number of all numbers in the row (I). But if we write the row of products 2, 4, 6, 8, 10 . . . (II), we will see that it contains only *even* numbers, and consequently only a half of all numbers in row (I) which contains *both* odd and even numbers. So we see that the number of numbers of row (II) is only a half of the number of numbers in row (I), being at the same time equal to it. How valuable pragmatically the concept of infinity is and how far it is from being just a dead abstraction, the following statement of Keyser shows: "Without infinite classes, as the late Henri Poincaré repeatedly said, there could be, strictly speaking, no such thing as science. Science is indeed the study of infinity."[1]

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[1] *Op. cit.*, p. 63.

[2] Sedgwick and Tyler, *op. cit.*, p. 281.

[3] *Op. cit.*, p. 297.

[4] Keyser, *The Human Worth of Rigorous Thinking*, New York, 1916, p. 148

The other discovery of modern mathematics which also works against absolute, exclusive dogmatism is that of hyperspaces. For the ancient and mediæval mind, it was impossible to think of four-dimensional or five-dimensional, or, in general, more than three-dimensional space or, to put it more concretely, of four or more mutually perpendicular lines. Aristotle speaks quite definitely: "The line has magnitude in one way, the plane in two ways, and the solid in three ways, and beyond these there is no other magnitude, because these three are all."[2] But now we have a fairly large literature on fourth and other higher dimensions; the physicist would study the matter for the solution of certain specific practical problems (for example, of the behaviour of the molecules of gases),[3] and

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[1] *Mathematical Philosophy*, p. 301.

[2] *De Caelo*, quoted from Keyser, *Mathematical Philosophy*, p. 405.

[3] See Keyser, *op. cit.*, p. 338.

Prof. Keyser goes so far as to declare that "hyperspaces have every kind of existence that may be warrantedly attributed to the space of ordinary geometry."[1]

The extension of the concept of space in another direction was brought about by the invention of the non-Euclidean geometries already mentioned. Here it would be worth while to add only a few words with regard to their practical significance. Says Prof. Ernest Brown, "In the application (of non-Euclidean geometries) to physics, the most important has been perhaps the recognition that our own space is not necessarily Euclidean and that we can only find out its nature by examining properties which we are able to observe and measure."[2]

The significance of all the features of mathematical reasoning outside of pure mathematics, in other words, the logical significance of them, may perhaps be best shown by the following tragic story, told by Keyser in his very excellent book, *Mathematical Philosophy* already so often quoted.

"Thirty years ago, I visited a locally eminent professor of mathematics in an excellent Middle-West college of the sectarian variety. I was astonished to find him in a sad mental state, worried, distracted, agitated, tremulous, unable to sleep or rest, thinking always about the same thing, and no longer able to do so coherently. What was the trouble? For many years he had been teaching geometry—Euclidean geometry—and his teaching had been done in the spirit and faith of a venerable philosophy. Like almost all the educated men of his time and like millions of others in the preceding centuries, he had been bred in the belief that the geometry he was teaching was far more than a body of logical compatibilities; it was not only true internally—logically sound, that is—but it was true externally, an exact account of space, the space of the sky and the stars, its axioms were not mere assumptions—not mere *ifs*—they were truths, 'self-evident' truths, and, like the propositions implied by them, they were not only valid but were known to be valid, and valid eternally, in a word, the geometry of Euclid was a body of *absolute knowledge* of the nature of space—the space of the outer world, other space there was none. That was a comforting belief, a congenial philosophy, held as a precious support of religion and life; for, though there are many things unknown and some perhaps unknowable, yet *something*, you see, was known; there was thus a limit to rational skepticism; our human longing for certitude had at least one great gratification—the validity of Euclidean geometry as a description of Space was indubitable. Such was the philosophy in which my dear old friend had been bred, and, with unquestioning confidence, he had devoted long years to the breeding of others in it. At length, he heard of non-Euclidean geometries, in which his cherished certitudes were denied—denied, he knew by *great* mathematicians, by men of creative genius of the highest order, he could not accept, he could not reject, he could not reconcile; the foundations of rational life seemed utterly destroyed, he pondered and pondered but the great new meaning he was *too* old to grasp, and his mind perished in the attempt, killed by the advancement of science, slain by a revolution of thought."[1]

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[1] Keyser, *Human Worth of Rigorous Thinking*, p. 256.

[2] L. L. Woodruff and others, *The Development of the Sciences*, New Haven, 1923, p. 29.

To be specific, the man was killed by the change in Logic. It was not any scientific discovery of an entirely new fact in nature, nor was it any fundamentally new development in philosophy, which in general showed the Universe as a whole to be quite different from what it was previously thought to be. It was primarily a change in ways of thinking, to which he could not adjust himself. Throughout his life he thought, for instance, that the sum of all the angles of a triangle was equal to 360° and that this was the only conceivable possibility—A is B but not non-B—and suddenly he was made to realize that it is also conceivable that the sum of the angles of a triangle is less than 360°—A is B and non-B. His mind could not stand the latter idea. The new ways of thinking killed him, and manifested thereby their power, their significance, and their inevitable necessity.

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[1] Keyser, *Mathematical Philosophy*, p. 363 ff.

The reasoning of the modern *physicist* has a very pronounced tendency to use very extensively the concept of motion in an interpretation of events in the Universe, and also to establish the continuity of different phenomena which at first appeared to be quite disconnected, in the sense of discovering that the difference between the phenomena is more one of degree or number than of kind. The molecular theory of gases and the kinetic theory of heat generally introduced into our understanding of nature so much dynamism, in comparison with the ideas of mediaeval man, that it is difficult to realize the immensity of the change. For us, everything is full of motion, as long as the temperature has not reached absolute zero—an occurrence which we have never had a chance to observe. The mountains of ice, sleeping calm and silent in the breathless semi-darkness of the long polar night, are for modern mind nothing but an ocean of different kinds of motion in the ice, in the air, and in the space above it. The empty nutshell lying still on the table would not to any extent suggest the idea of motion to a mediaeval man (provided that he did not happen by a queer chance to be an Epicurean), but we now know that if all the distances covered in one second by the molecules within the shell were placed together in one line it would be more than one billion times as long as the distance between the earth and the sun.

After Huyghens any sound, any light, any colour is for us but a different form of motion, and not only in the sense of a rather vague conjecture, for we definitely know the nature, kind, speed, length, and so on of the wave in each of them.

It is impossible to overestimate the methodological, normative value of the formulation of the law of universal gravitation. The wide range of events, so utterly different for pre-Newtonian mind, including the revolution of the moon round the earth or of the earth round the sun and the falling of Newton's famous apple (if it ever existed) or of a common pin, were proved to be of the same kind, differing only in degree, in the intensity of the force of gravitation.

The next great generalization—the establishment of the mechanical equivalent of heat by Mayer and Joule (1845), followed by the formulation of the doctrine of the conservation of energy, so wonderfully presented by Helmholtz—has proved the continuity of all change in the universe, in the sense that any physical work, any material motion, is only a transformation of previously existing kinetic or potential energy which is destined to manifest itself in one form or another in the future.

The explanation of the nature of the spectral colours, the discovery of ultra-violet, infra-red, and X rays, Hertz's discovery of electric waves, Maxwell's electromagnetic theory of light, have established the most wonderful continuity between events which seem to be quite different, and again have shown that the difference between them is not in kind, since all of them are of the same nature, but in the number of vibrations per unit of time and in the length of the waves.

The next great generalization of physics, the concept of the electron and the electro-magnetic theory of matter, leads us to chemistry, or at least to the boundary region between physics and chemistry. The boundary regions, by the way, are by themselves of considerable interest to the discussion. Prof. Johnston says: "Indeed, the several sciences have in the past been too far apart from one another, and we should now seek increased co-operation, for it is precisely in the boundary regions between them that the most valuable advances in the immediate future will be made."[1] This is very true and very significant. The tendency to abolish the separating and limiting border-lines, which was traced in the development of physics, now manifests itself also outside the subject-matter of separate sciences, helps to establish continuity between the sciences themselves, and, most important of all, promises the most valuable progress in the immediate future.

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[1] L. L. Woodruff and others, *op. cit.*, p. 127

But before we go on to chemistry, we cannot leave mathematics and physics without mentioning Einstein's theory of Relativity. This modern conception, which revolutionizes the whole edifice of science, manifests all the four aspects of scientific reasoning mentioned above. The part which the element of relativity plays in it is obvious. Even the most fundamental and independent entities, like Matter and Time, are now considered to be something relative and, what is especially significant, relative to velocity of motion From that point of view, probably no other conception has ever made dynamism, motion, and change so definitely predominant as this theory. The range of events among which continuity is established by the theory of relativity is enormous, it practically embraces everything, from the whirling of electrons within an atom to the revolution of planets round the sun and to the transmission of light through the Universe. The degree of pluralistic open-mindedness required for acceptance, for instance, of difference in mass for the same body at its different velocities or of different times for different bodies is also tremendous

The purely theoretical progress of *chemistry* takes the form of the establishment of closer and closer continuity between different substances, or, in other words, in the decrease of differences in kind and essence and the increase of well-established, definite differences in degree and numbers. The introduction of the concept of element has reduced the practically infinite number of different bodies and substances to a combination, in different proportions, of about 92 elements. The concepts of atom and molecule and Mendeleeff's discovery of the periodical law made it possible to think of the characteristics of the elements and, to a certain extent, of their compounds as a function of the numbers expressing their atomic weight. The discovery of radio-activity and the electron and the brilliant work of F. F. Thomson, Rutherford, Bohr, Moseley, and others have reduced the number of primary components of all bodies to two, the negative electron and positive proton, and we now think of elements and their chemical properties as a periodical function of the number of their "free" electrons or, better, of the units of excessive positive electric charges on the nucleus of the atom.

The advance in chemical reasoning of the process of transforming qualitative differences into numerical ones is really remarkable, most impressive, and very significant from the methodological point of view. The development of other fundamental concepts of chemistry also gives a very good illustration of the tendency towards abolishing the rigid, definite border-lines even between quite contrasting ideas. Take, for instance, the concept of equilibrium. "The conception of equilibrium in chemical processes constitutes," says Prof. Johnston, "the central idea of what is commonly called physical chemistry, which, however, would be better termed theoretical or general chemistry, since it deals with the general principles of the science."[1] The notion of equilibrium introduced by Guldberg and Waage in 1865 and elaborated later by Gibbs, is quite a modern concept and may be called a dynamic equilibrium. Being apparently an absence of change, it is actually a continuous change in two opposite directions which neutralize each other. In the words of Prof. Johnston, it is "an apparently stationary condition . . . a state of equilibrium," when "the tendency of the reaction to go forward is just counterbalanced by the tendency of the reverse reaction."[2] The following equations give an illustration of it. $CO + H_2O \rightleftarrows H_2 + CO_2$, or $3 Fe + 4 H_2O \rightleftarrows Fe_3O_4 + 4 H_2$. The concept smoothes over the contrast both between continuous change and a state of rest, and between a certain direction of reaction and its opposite.

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[1] L. L. Woodruff and others, *The Development of the Sciences*, p. 117.

[2] *Ibid.*, p. 115.

The development of the concept of colloids is instructive also. Graham (about 1830) divided "substances into two categories—the rapidly moving crystalloids, typified by salt, and the slow moving colloids, typified by gum-arabic or gelatine For a long time the distinction persisted . . . and only after 1900 did it become evident that we should not speak of colloids as a distinct class of substances, but may speak only of the colloid state."[1]

The division of substances into organic (produced by living organisms) and inorganic (which are the result of processes in inanimate nature) was previously quite fundamental and distinct. But since the epoch-making experiment of Wohler who, in 1828, produced urea, and since the subsequent development of organic chemistry, the division has lost its meaning; and the modern distinction between organic and inorganic chemistry is purely technical and conventional, and the two branches may be roughly defined as the chemistry of carbon and the chemistry of other elements. The biological and philosophical significance of the destruction of the barrier between organic and inorganic is quite obvious.

Astronomy was the first discipline to commence the modern scientific development, with Copernicus's *De Revolutionibus Orbium Cœlestium*, and was the first also to introduce into science one of the most fruitful of all ideas, that of evolution in Kant's and Laplace's nebular hypothesis of the solar system. In its progress, astronomical reasoning shows the all four aspects of modern thinking mentioned above. For the pre-Copernican mind the Universe was something fairly definite, fairly simple and limited Its centre was definitely known and near to us—it was our own globe. Its limit, its distinct borderline, was thought, even by Copernicus, to be a sphere of fixed stars. The concept of the world was definite, convincing, and exclusive of all other worlds and possibilties. Now, instead of this, we have no centre at all for the Universe, or, in another interpretation, any point may be considered as its centre. Our world, the solar system, turned out to be only one infinitesimal part of the whole Universe among many other possible systems like ours. Furthermore, we can now think not only of many worlds, but of many Universes, as the Pluralism of Charles Renouvier and William James suggests. Thus even the concept of the Universe at present may become relative, in spite of the apparent contradiction in terms.

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[1] L. L. Woodruff and others, *The Development of the Sciences*, p 122

The amount of motion in the modern Universe has increased tremendously. Having made the earth revolve round the sun, we have not stopped the sun, but have ascribed to it the speed of 12½ km. per second. The velocities of "fixed" stars are established at from 27–100 km. per second.

Change and continuity are the foundation of the nebular theory. If we could turn time back, and if we could watch the sun and planets going back to their origin, we should see them gradually absorbed into the primordial nebula. It is true that modern views in geology, physics, and celestial mechanics are opposed to the old nebular theory, and that, in the words of Prof. F. Schlesinger, "without radical reconstruction the nebular hypothesis can no longer serve as a reasonable theory of the earth's origin."[1] But whether we accept Chamberlin's planetesimal hypothesis, or any other, the difference would be only in the ways and methods of evolution. The fact of it can hardly be challenged.

As the most influential single book in *geology*, Lyell's *Principles of Geology* (1837) stands unconditionally acknowledged and without rivals. Its great mission is definitely stated in its full name, which is: *Principles of Geology: being an attempt to explain the former changes of the earth's surface by reference to causes now in operation.* In other words, it was an attempt, and quite a successful one, to erase the artificial border-line between past and present, to abolish the difference in kind between them, and to introduce continuity in our ideas of the history of the world.

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[1] *Ibid.*, p. 172.

After Laplace's *Exposition du système du monde*, Lyell's work was the next great landmark for the growth of the scientific concept of evolution, and it leads us directly to the third great advance of the concept, to Darwin's *Origin of Species*. The *Origin of Species* was not only, beyond doubt, the most influential book of the past century in biology, but probably the most influential book altogether, "*the* book," of the nineteenth century. The influence which it has exercised outside of biology shows that its significance lies not so much in certain specific facts put forth, or in certain biological (in a broad sense) problems wonderfully solved, but in its general ways of thinking, in its logic, in its revolutionary concepts, as tools especially fit for modern reasoning. The *Origin of Species* for the pre-Darwinian mind was not only a startling and novel doctrine, it was an absurdity, a contradiction in terms, and "an intellectual revolt," as Dewey puts it in his essay, *The Influence of Darwin on Philosophy*.[1] And Darwin's great historical mission and destiny has been to establish this "contradiction in terms." Before him, the concept of species stood for something unchangeable, absolute, definitely patterned for ever, untransmutable into other members of the groups, and separated from them by quite a distinct, sharp border-line. Darwin transformed it into a new "species" concept, which signifies something, in a sense, rather definite and tangible, but at the same time continuously changing; something that, being determined by environment, in its origin in the course of time and in its structure in the realm of space, gradually merges into other members of the group and in that way is closely related to them. The new dynamic concept and the masterly transmutation into it of the old static concept expresses the spirit of the new logic so well that "Darwinism" in its logical aspect became a symbol of the new and modern ways of thinking and a pattern and guiding principle upon which to build the new dynamic concepts in other fields of reasoning. And this was what has made the *Origin of Species* "the book" of the nineteenth century.

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[1] John Dewey, *The Influence of Darwin on Philosophy*, New York, 1910, p. 1 ff

Besides the idea of evolution, so predominant in modern biological science, another rather fundamental biological concept, that of death, provides a good illustration of the typical features of scientific reasoning. To the mind of the average man in the street, to so-called "naïve realism," there are few ideas more definitely opposed than life and death, and probably nowhere else is the sharp dividing-line between two opposites so overwhelmingly and tragically important and real. What is on one side of it is so different from what is on the other side. "It is better to be a live dog than a dead lion," as the Romans put it.

To modern science the situation is not so definite at all. First of all, there are certain phenomena of which we cannot tell definitely whether they are death or not, or rather which are death and which are not. For instance, when a Paramecium or any other single-celled animal divides into two new protozoans of the same kind, it is not death, since no living matter becomes dead matter. But, on the other hand, it is death, because the parent Paramecium definitely ceased to exist as a living organism, as a living whole. Then, in the case of dry seeds and spores, frozen fish, frogs and snakes, people drowned or in the state of deep lethargy, very often it is impossible to say whether they are dead or alive. Only the subsequent appearance or non-appearance of resuscitation can answer the question.

Furthermore, even when the fact of death is indisputable, it is impossible to tell the exact moment of death, the moment up to which the organism still lived and after which it was definitely dead. In one of the *Monographs* *on Experimental Biology* edited by J. Loeb, T. H. Morgan, and W. Y. V. Osterhout, we read: "Every child knows that all tissues do not die at the same time. . . . As Harrison points out, 'almost the whole of our knowledge of muscle-nerve physiology, and much of that of the action of the heart, is based upon experiments with surviving organs.'"[1] Dr Carrel "found that almost all the adult and embryonic tissues of dog, cat, chicken, rat, guinea-pig, and man could be cultivated in vitro";[2] in other words, outside the body in a proper nutrient medium. The extent to which the survival of separate tissues may continue is illustrated by the following fact: a strain of connective tissue obtained from a piece of chick heart was alive for nine years, or longer than the average longevity of a chicken itself.[3]

All this makes us look upon death, not as an instantaneous occurrence, but as a gradual process extending through a certain length of time. But more thorough investigation shows, not only that death is a process in time, but that it is a continuous process, practically inseparable from life processes. In the same *Monographs on Experimental Biology*, W. Osterhout writes: "Studies undertaken from this point of view lead us to look upon the death process as one which is always going on, even in a normal, actively growing cell. In other words, we regard the death process as a normal part of the life process, producing no disturbance unless unduly accelerated by an injurious agent which upsets the normal balance and causes injury, so that the life process comes to a standstill." In an accompanying footnote he remarks: "The general conception that the death process goes on continually is in harmony with the ideas expressed by many physiologists from Claude Bernard (1879; 1, 28) down to the present day. Cf. Lipschutz (1915)."[4] Finally, to emphasize still more the continuity between life and death, we are told by Minot that the rate of approaching death, of senescence, of "dying," is highest in childhood. As his fourth law of age, he asserts "Senescence is at its maximum in the very young stages and the rate of senescence diminishes with age."[1] This interpretation of the concept of death shows definitely the emphasis on process, the establishment of continuity between opposites, quantitative differentiation instead of qualitative, and a certain degree of pluralism.

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[1] R. Pearl, *The Biology of Death*, Philadelphia, 1922, p. 58.

[2] *Op. cit.*, p. 50.

[3] *Op. cit.*, p. 63.

[4] W. Y. V. Osterhout, *Injury, Recovery, and Death in Relation to Conductivity and Permeability*, Philadelphia, 1922, p. 16.

The analysis of other fundamental biological concepts, such as those of organism or individual, for instance, would yield a similar result. While the difference and gulf between an organism or individual and an association of individuals, society, on the one hand, and between an organism and its organs, on the other, looks so obvious, the fact is that in many cases, in *Volvox globator*, for example, or in colonies of certain hydroids or of the Siphonophores, it is very hard to tell whether a certain conglomerate of living matter is an organism, *i.e.*, an individual, or an organ, or an association of individuals.

The general development of *psychology* is characterized by the same tendency to replace clear-cut divisions and water-tight compartments by something more flexible and continuous. From the conception of mind as a mechanical combination of separate thoughts, volitions, and feelings or as a conglomerate of definite "faculties," we have come to thinking of mental life as a fusion of rather fluid "reactions," "functions," "complexes," "behaviours" of different kinds, "configurations," and the like. The prevailing current attitudes towards mental life may well be described in the words of Marshall, who regards mind as a "complex of diverse emphases within a whole psychic pulse," and says that, "in so far as these emphases display observable characteristics, the average man gives them special names, *e.g.*,

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[1] C. Minot, *The Problem of Age, Growth, and Death*, New York, 1908, p. 250.

"thoughts," "desires," "believings," "emotions," "sensations," etc [1]

A good illustration of this general tendency to continuity is provided by two narrower but nevertheless very fundamental concepts of psychology, "Intelligence" and "Mental" or "Psychic." Elementary common sense and judicial practice divide all people into two separate groups—normal people and idiots or feeble-minded people. More attentive observation reveals a division into feeble-minded people, average people, and geniuses The next step in the direction of thorough analysis gives a scale something like: idiots, morons, dull, normal, bright, very bright, geniuses. And, finally, modern mental tests introduce a very continuous curve of distribution of intelligence from the lowest levels to the highest in terms of I Q's., with definite emphasis on quantitative interpretation of the concept. These steps in the elaboration of the concept of intelligence coincide fairly well with its actual historical development in psychology.[2]

If the development of the intelligence concept represents the experimental aspect of modern psychology, the treatment of the problem of mental and physical, "mind" and "non-mind," by H. Hollingworth and B. Russell introduces the more speculative features of our studies of mental life. Hollingworth points out that the distinction between "mental" and "physical" facts—for instance, between hunger, anger, desire, belief, emotion, and the chair, the table, the fireplace—is relative and statistical. Between the "natural order" and "mental order" "there is as a matter of fact not a gulf but a gradual transition and continuity."[3] He fills this gulf with facts like "a wave of patriotism," fever, plague, beauty, and so on, and affirms that generally all facts are psychophysical. The difference of the degree of "psychic-ness" and "physic-ness" of facts depends on the number of persons reporting the fact. The more identical reports we have, the more "objective," "physical," "material," is the fact. In the same way, Hollingworth also establishes continuity between "feeling a difference," "judging the difference," "holding a belief with respect to it," and "perceiving it," and makes the gradation a function of the degree of confidence experienced.[1]

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[1] Quoted from H L Hollingworth, *The Psychology of Thought*, New York, 1926, p 174

[2] R Pintner, *Intelligence Testing*, New York, 1923, ch 1, ff.

[3] *Op cit*, p 170

B. Russell's point of view may be given in his own words: "Physics and psychology are not distinguished by their material. Mind and matter alike are logical constructions; the particulars out of which they are constructed have various relations, some of them are studied by physics, others by psychology. . . Mind (as contrasted with matter—B. B. B.) is a matter of degree, chiefly exemplified in number and complexity of habits."[2]

Thus psychology completes our brief review of sciences which either are "exact" or at least try to be so, and takes us back into the domain of more philosophical and less exact disciplines like Logic, epistemology, and ontology.

All the illustrations taken from different dominions of scientific reasoning definitely justify the statement set forth above, that modern thinking in its best examples is extremely dynamic; that is, it is interested almost exclusively in different kinds of change, and saturates its concepts with motion so generously that it sees nothing but motion even where naïve realism or common sense observes only a state of perfect rest.

The other outstanding characteristic of scientific reasoning, as the same illustrations emphasize, is that it uses quite extensively, as its most powerful and favourite device, the establishment of continuity among studied facts. The continuity is sometimes primarily in Time and to a certain degree in substance, and sometimes primarily in a certain definite property or characteristic The former may be illustrated by the continuity between a boy five years old and himself at the age of eighty-five, the latter by the continuity between the intelligence of the dullest member of any large social group taken at random and the intelligence of the brightest member of the same group.

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[1] H. L. Hollingworth, *The Psychology of Thought*, New York, 1926, p. 173 ff.

[2] B. Russell, *The Analysis of Mind*, London, 1921, pp. 307, 308.

The term *continuity* has already been used so much in this discussion that it is now both possible and desirable to sum up the different aspects of continuity, and to give its definition as a logical term and as it will be understood in this discussion.

Continuity, in the simplest case, may be observed when we have (*a*) two not identical events which may be called the poles of the continuity, (*b*) a certain characteristic common to both of them, which may be called the direction of the continuity; and (*c*) several transitional (in the given direction) forms between the two poles, steps (or points) of the continuity. "Transitional" here has the accent on its Latin *ire, to walk*, and means something which can move through or be moved through, or actually moves through or is moved through, so as to connect two previously disconnected points, and, furthermore, not only something which has connected the two points, but something which has established a permanent connexion between them, so that transitional becomes almost synonymous with passable, traversable. The forms between the poles are transitional, when our thought can move easily from one pole to the other without stops and halts through all the steps (including the poles), as members of the same group, differing in degree rather than in kind. Continuity, understood in that way, is a direct antonym of separateness or separation and a near synonym of traversability.[1]

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[1] Since such an outstanding and up-to-date work as W E Johnson's *Logic* uses as one of its fundamental notions "continuant" and thus implicitly introduces the idea of continuity, it is worth while to compare the notion of "continuant" with the concept of continuity as presented here. They denote quite different ideas. The "continuant" interprets

It is very important to notice that, in thinking of the concept of continuity, we must never forget that the concept itself, being so fundamental and primary in reasoning, must always be understood from the point of view and in terms of continuity also. In other words, we must never forget that the concept of continuity manifests itself also in the form of a continuum, that is, it denotes, not something absolute, exclusive, not a group of identical situations, but a continuous series of situations differing one from another in degree of continuity (or separation). The difference of degree here is a difference in difference between steps of continua. In certain continua the difference between two neighbouring steps is very small, in others quite considerable. If the difference is hardly appreciable, as small as we wish it to be, or, in other words, "infinitesimal," then we have a perfect and compendent ensemble called the mathematical continuum of the second order. In non-technical language, the nature of the mathematical continuum will probably be best expressed in the following characteristic of it: "Any value between the greatest and least values of a continuum (between its poles, in other words), can be found at least at one point of the continuum."[1] If the difference between steps cannot be made as small as is desired, then we have continua observed in other sciences than Mathematics. We shall have that kind of continuum if, for instance,

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the essence of the nature of things. Its meaning is ontological, or "constitutive" in Johnson's terms. The "continuity" describes the essence or nature of reasoning and therefore is logical or, again in Johnson's terms, "epistemic." Continuity is contrasted with separation, the "continuant" with its states. The concepts closest to the continuant and its states in the present work are "process and its product." Moreover, as far as its general logical standpoint is concerned Johnson's *Logic* is more static than dynamic, in the sense that it is more a Logic of Excluded than Included Middle.

[1] In technical language, the idea of mathematical continuity may be expressed as follows: "A function $f(x)$ of one variable x is said to be continuous at a point a if (1) $f(x)$ is defined in an interval containing a, (2) $f(x)$ has a limit at a, (3) $f(a)$ is equal to this limit." See A. E. Love, "Function," in *Encyclopaedia Britannica*, 11th ed., vol xi, p. 304.

having measured the intelligence of the members of a very large group, say of all living white people, we drop out all duplicate cases (in terms of our measurements) and arrange what is left in a series ranging from the lowest case up to the highest. Obviously it will not be a perfect and compendent ensemble or continuum, because we cannot make the difference between steps as small as we would probably wish, but nevertheless it will be a continuum, in the sense of the relative definition above. And it is easy to see that it would be a better continuum than we should get, for instance, by measuring the intelligence of a group of one hundred or twenty-five people.

It should be observed that absolute, complete perfection of the mathematical continuum exists only in potentiality and outside the controllable world. It is conceivable but not attainable; it may be comprehended but never observed, not even imagined. Because of this, for any practical purposes, for controlling environment (and this discussion deals only with pragmatic problems), the potentially perfect continuum is of no great importance. We can never realize it completely, and for all practical purposes we use imperfect or relative continua, no matter how small the difference between steps is made. Whether, for example, we treat π as 3.14, or its value computed to 707 decimal places (Shanks, 1854), in neither case are we really in a perfect continuum, and the difference between numerical continuity and the continuities dealt with outside mathematics is practically only relative, not essential.

From the relative point of view, when the difference between the steps becomes inappreciable, equal to zero, the continuity becomes identity; when the difference is so great that our thought cannot easily pass from one step to another and consider them members of the same group, continuity becomes separation. Thus continuity itself may be thought of as a case of a continuum whose poles are Identity and Separation.[1]

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[1] The relative conception of continuity must be kept in mind when considering the logical significance of Plank's quantum theory. This

Now, if dynamism and continuity are really the most outstanding characteristics of modern scientific thinking, the next question to be considered is, what kind of Logic best fits that thinking?

theory, which is gaining more and more recognition now, in its present form, depicts the ultimate structure of the Universe as discontinuous from the point of view of mathematical continuity, and in this way works against the principle of continuity; but, from the point of view of the logical and relative continuity here presented, the Universe, according to the quantum theory, is a continuum of a very high degree of continuity, and, in this aspect of it, the quantum theory indeed completes the above list of illustrations from different sciences upholding continuity as a predominant aspect of modern scientific reasoning

CHAPTER IV

THE BACKGROUND OF STATIC LOGIC AND FOREFRONT OF DYNAMIC LOGIC

If men philosophised in order to escape ignorance, it is evident that they pursued wisdom just for the sake of knowing, not for the sake of any advantage it might bring … More necessary indeed, every other science may be than this, more excellent there is none —ARISTOTLE

Human knowledge and human power meet in one; for where the cause is not known the effect cannot be produced Nature, to be commanded, must be obeyed —FRANCIS BACON

BEFORE answering the question which Logic would best fit modern thinking, it may be instructive to see what experience, what general attitude and philosophy of life, fitted the Aristotelian classical Logic so well, being its background and cause as well as its product and output. When we say " Aristotelian Logic " we certainly do not mean Aristotle's logic. The Logic formulated by Aristotle was not his logic in the sense that it was created or invented by him from nothing or used by him alone The ways of thinking described and formulated by Aristotle in his *Organon* had been previously used by the intellectuals of those days, especially by Plato, and were used later all through mediæval times down to the present. It is a curious fact, but true, that in a certain sense Aristotle himself was not only more modern than his predecessors, which is natural enough, but also more modern than his most faithful followers over a thousand years later, who either knew only a part of his teaching or neglected its experimental and inductive elements altogether. Thus, in looking for the experience underlying Aristotelian Logic we have to consider the experience of European humanity up to, roughly speaking, the fifteenth or sixteenth centuries after Christ. For the sake of brevity and convenience, this experience may be called pre-modern, as contrasted with modern.

The contrast starts with the most fundamental, most primary aspect of experience. Dewey says that experience "includes an active and a passive element peculiarly combined,"[1] or, in other words, that it is "a matter of *simultaneous* doings and sufferings."[2] The notion of experience as simultaneous doing and undergoing, if taken with all its implications, is of tremendous import, and means that any bit of experience always involves both elements but in different proportion. If the active element, doing, is greater, we have a controlling reaction, a tendency to change, to transform our environment; if the passive element is stronger, we have a consummatory reaction, a tendency to appreciate the environment positively or negatively without special effort to transform it. In the pre-modern experience the latter element, the consummatory reaction, was quite predominant over the controlling tendencies. For Aristotle himself the ideal life was a life of contemplation. The same is true of Thomas Aquinas. For Plato the whole universe was a form of magnificent contemplation, a play of ideas. For the Neoplatonists and all mystics, spiritual reunion with the One and liberation from the power of matter in one form or another were the only aim of life. Any list of the topics most favoured in mediæval debates would show how far they were from the tendency to transform environment or even from the possibility of controlling the events discussed.

Contemplative as it was in its aims, the pre-modern mind was not less contemplative in its methods of attack. For Plato, the greatest tool for acquiring truth was dialectics, speculation. When Galileo, the prophet of the new scientific spirit, tried to prove by experiment that the acceleration of falling bodies does not depend on their weight, the reaction of the learned conservatives was not to investigate the experiment or to arrange a new one, but to go back to their studies and look into books for the solution of the problem And, what was probably even more important than theoretical aims and methods, the everyday routine and life of the typical intellectuals of the days of the schoolmen consisted in the continuous reading or writing of books or the discussion and interpretation of them, the mere contemplation of words and ideas Aristotle himself was more interested in facts and environment, but even his experience was limited by observations which, though very keen, were almost exclusively contemplative. Even he did not make much use of experimentation, as a systematic rearrangement, or manipulation of environment How far this kind of activities—practical and technical—was separated from contemplative knowledge and science, is shown by the fact that Archimedes, as Prof Robinson writes, " disdained to make any record of his ingenious devices, for they were unworthy of the noble profession of a philosopher." [1]

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[1] John Dewey, *Democracy and Education*, New York, 1910, p. 163.

[2] John Dewey and Others, *Creative Intelligence*, New York, 1917, p. 10.

In the attitude of a spectator and admirer, as opposed to that of a master and engineer, the typical characteristics are emphasis on quality versus quantity and emphasis on the static aspect of nature versus the dynamic.

The appreciative and passive attitude is intrinsically qualitative, while successful controlling action is impossible without quantitative data A few simple illustrations will make this clear. To a gourmet a fine dinner in a good restaurant is a continuous procession of different " qualities " . the remarkable flavour of the fruit cocktail ; the unusually fine taste of the soup ; the delicious tenderness of the meat , the wonderful mellowness of the fish , the refreshing originality and piquancy of the dessert. To the chef of the restaurant or to his assistant, still learning the high mysteries of the Fine Art of Cooking, the same meal is but a big conglomerate of "quantities": how much of each fruit must be put into the cocktail, the proper proportion of different vegetables in the soup, how long the meat must be roasted, how many degrees the temperature of the oven must be for the fish, how many different sweets must be taken to make an original but not too fanciful dessert, and so on. To make the contrast expressive and graphic, it is enough to compare the description of the Cratchits' Christmas dinner in Dickens' *Christmas Carol* and the corresponding pages of a good cookery-book. The appearance on the table of the goose ("*such* a goose, Martha!") "a feathered phenomenon to which a black swan was a matter of course," of which Bob said that "he didn't believe there ever was such a goose cooked," and then the solemn entrance of the pudding ("Oh, a wonderful pudding!"), the pudding with "a smell like an eating-house and a pastry-cook's next door to each other, with a laundress's next door to that," the pudding of which "Bob Cratchit said, and calmly too, that he regarded it as the greatest success achieved by Mrs Cratchit since their marriage"—all this introduces so many different almost imperceptible nuances of delight, admiration, enjoyment, and happiness that they look nearly exclusively qualitative Coming back to a cookery-book, we are in the realm of quantities. It tells us that "a goose twelve weeks old is known as a green goose and six months old as a gosling," it instructs us, after salting and peppering the goose, to "lay six thin strips of fat salt pork over breast," then to bake it "two hours." Then "baste every fifteen minutes with fat in pan. Remove pork last half hour of cooking," etc. The prescription for stuffing is a continuous row of figures: 2 cups hot mashed potato, 1¼ cups soft stale bread-crumbs, ¼ cup butter, 1¼ teaspoons salt, and so on. The pudding is treated in the same way—strictly quantitatively.

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[1] James H Robinson, *The Mind in the Making*, New York, 1921, p 113

In music the same relationship of controlling-appreciative and quantitative-qualitative approaches also holds true. An amateur—a fine musician—when unfavourably impressed by a poor performance of a symphony, would describe it to his friend as dull, lifeless, very poor, entirely misinterpreting the score, stupid, heavy, awkward, and so on; while to a conductor who is disappointed with the performance of his orchestra the main problems are such as, how much slower the first part must be played and how much faster the last part, how much louder the violins must play here and the clarinets there, how much more prominent the main theme should sound here and how much more *piano* the whole orchestra should play there, and so on.

A cathedral, or a palace, or a sky-scraper may appear to a cultured tourist beautiful, magnificent, inspiring, and tremendous, or depressing, ugly, and tasteless, but to its architect and builder it means an enormous amount of calculation and measurement and endless columns of figures.

This problem in general form (though from a slightly different point of view) is discussed at length and in a masterly way by H. Bergson in his *Time and Free Will*. After a thorough analysis of the problem, he "found that psychic phenomena were in themselves pure quality or qualitative multiplicity and that, on the other hand, their cause situated in space was quantity." He also says: "Pure quality . . . is the state of consciousness and pure quantity . . . is necessarily space." "If magnitude outside you is never intensive, intensity within you is never magnitude."[1] Obviously the passive aspect of experience, "undergoing," appreciation, is predominantly the state of consciousness in Bergson's terminology, and therefore predominantly qualitative, while the controlling aspect of experience, producing changes in the environment—in other words, in space around us—is predominantly quantitative.

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[1] Henri Bergson, *Time and Free Will*, London, 1912, pp. 224–225. Cf. also ch. 1, ff.

So strong is the tendency of a contemplative mind to interpret everything qualitatively that it tries to imbue even the very symbols of quantity, numbers, with certain qualitative properties For many people even now, 3 or 7 or 12 is a good, favourable, nice number; while 13 is evil, unlucky, and dangerous. There is an old mediæval Russian religious psalm, consisting of a series of questions, *What* is one? What is two? and so on, and the answers are: One is God, two are the two natures of Christ, divine and human, three is the three persons of Trinity, and so on Very probably, for the authors of the psalm, the answers really explained what was the nature of the number one or two or three, as well as corresponding explanations satisfied Pythagoreans or E Levi.[1]

It is quite obvious that the contemplative mind, as opposed to the controlling mind, by its very definition, is not likely to produce any changes in its environment, but would it not probably like changes to occur of their own accord around it? If "undergoing" or appreciation is of a positive character, that is, if it is satisfying, then obviously, again, by definition, there would be no want, no tendency to change. And the higher, the more complete enjoyment is, the greater is the opposition to any change. In a rather expressive form this attitude is described in the following colourful Oriental song.

The turbulent waters of Kur are seething and foaming
A bright day is dawning!
How blithe my heart and how free my spirit,
Could it remain thus for ever,
Oh, could it remain thus for ever . . .[2]

The same tendency to fix, to eternalize the satisfying state of affairs is well expressed in the behaviour of St Peter and St James and St John at the transfiguration of Christ. Socially and politically, conservatism is nearly always backed by social groups which in one or another way have profited by the existing social order.

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[1] Eliphas Levi (A. L. Constant), *Transcendental Magic*, Chicago, 1910.

[2] *A Persian Song*, the English version by J. M. Soskice

If the appreciation is of a negative kind, if it means one or another form of suffering, then there is generally a tendency to escape from the suffering and to avoid the causes of it. But this tendency is quite different from the controlling tendency, which seeks to transform environment. The aim here is not to change environment but just to withdraw oneself from it, or to get rid of it. The passive, contemplative character of the reaction is quite clearly seen in cases where the contemplative approach to life is very consistent. The more contemplative the attitude is towards life, the more it justifies and accepts suffering. A determinist sees in it the will of God. Mystics would say that it purifies the soul. A modern philosopher known for his emphasis on the æsthetic aspect of experience says "Pleasure for the beautiful body, pain for the beautiful soul."[1] Hardships of different kinds have been the foundation of monastic spiritual training. Oriental ascetics would quite voluntarily and enthusiastically go into marshes to be bitten almost to death by mosquitoes or seek other tortures and martyrdoms. All this is in inverse proportion to interest in environment and in direct proportion to contemplation. But even a rather neutral form of contemplation, not extremely pleasurable, nor definitely painful, is also opposed to changes. Buddhism, which emotionally represents this kind of mentality rather well, holds as its ideal the attainment of Nirvana, which is nothing else than an attempt to get rid, once and for ever, of all the changes and metamorphoses of our universe. According to the highly specialized Yoga doctrine of contemplation, the way to union with the Eternal Unity is by *Samadhi*, or by a continuous contemplation of contemplation without any other content. And this love for the eternal, permanent, stable, and unchangeable is quite characteristic of the pre-modern, contemplative outlook. Change is intrinsically bad, sometimes even evil in itself. For Plato, real wisdom was not knowledge of the changeable

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[1] *The Prose of Oscar Wilde*, p. 759 (*De profundis*)

"appearance of things" but of the eternal ideas above it. For him the universe was so completely made in advance, once and for ever, that nothing new could be known, and all knowledge was only the recollection of something previously known. Aristotle, substituting "forms" for Plato's "ideas," considerably reduced the separation between the shaping factor and the material used, but he did not abolish it, by any means. For Plato, the universe of experience was like a projection of certain words or signs from far away on to a screen; for Aristotle, it was more like the formation of the same symbols or words on paper by a typewriter But for both of them the eternal, unchangeable specific patterns were primary to the reality of the senses, and the same is true of all mediæval thinking up to the victory of nominalism over realism and conceptualism. Thomas Aquinas thought that the forms abode eternally in God God was considered eternal and unchangeable because any change or even possibility of change would deprive him of perfection. So deep was this conviction of the existence of formative patterns as the foundation of the world, that any considerable deviation from these patterns, especially in living forms, such as monsters and malformations of all kinds, attracted an amount of attention which surprises us They were mentioned in chronicles, painted by artists, and discussed everywhere And not only was a certain curiosity excited, but horror and uncanny uneasiness were induced even more. To the mediæval mind these deviations looked like something utterly unnatural and unholy, an attempt of the rebellious Prince of Darkness to destroy the harmonious and orderly world of God

This attitude toward change and dynamism leads us to the fourth aspect of pre-modern experience, namely, the tendency to distinguish, differentiate, isolate, describe as exhaustively as possible, define perfectly, and establish once and for ever the eternal patterns of our universe. They could be ideas, forms, concepts, substances, essences, entities, species, properties, powers, faculties, forces, elements, doctrines, creeds, monarchies, guilds, social classes, customs, virtues, sins, laws, propositions, definitions, and so on, and so on, but all of them must be established, defined, and classified For pre-modern thinkers, the universe was a collection of static, eternal, qualitative, independent, and clean-cut units, somewhat like a great museum of different dead specimens, and their general intellectual attitude was like that of a curator of the museum, or of an old-fashioned naturalist, watching scrupulously, differentiating, specifying, classifying, and describing To such a general attitude and trend of mind no other instrument, or "organon," of thought would be so perfectly fitted as the classical Aristotelian Logic with its fundamental law, "A is B but not non-B," its exhaustive definition (at least in attempt), its static terms, its quantitative indices in the form of "some," "all," or "no," and its mechanical, syllogistic manipulation of propositions

Now, after our excursion into pre-modern thinking and its cultural background, let us return to the problems of modern thinking As has been stated above, the Logic for which this discussion ventures to look is a logic of reasoning, tested by its ability to control our environment, a Logic which would fit modern thinking, a Logic which is dynamic, interested in quantitative differences, and seeks to interrelate, connect, and unite different elements of our experience The suggestion arises at once that this Logic must be based on the law "A is B and non-B simultaneously" It must have more efficient ways of definition, more exact, quantitative indices, and more flexible means of reorganizing our cognitive experience

The attempt to find and to construct such a Logic will begin with a study of the logic of John Dewey's writings, or, more definitely, of the ways of thinking embodied in his writings, from which generalizations will be drawn. Dewey's works are here chosen because, from the point of view of this discussion, they present the most consistent and most efficient single specimen of modern logic. The method of attacking problems employed by Dewey, if generalized and explicitly stated, would give a solid foundation for the further development of the theory of dynamic Logic.[1]

It can hardly be mere chance that the reasoning of an American philosopher supplies an exceptionally fine sample of modern logic. We must not forget that control of environment is the keynote of modern experience and consequently of modern thinking. If we bear this in mind, it is not difficult to see why an American writer would lead. There are many reasons for this. In no other country in human history has such a large percentage of the population come from other countries, and that not in the form of an invasion by a large group with fixed organization and traditions, but as individuals or in relatively small groups. America is primarily a country of immigrants, who are at the same time emigrants in respect of their native countries. It makes no difference whether they came on the *Mayflower* or as steerage passengers on a modern transatlantic liner. They are all people who, in the first place, were so sensitive to their environment that they could no longer stand it, and, secondly, were not only sensitive but extremely active, for, without an attempt to justify or beautify their hardships, they decided to create a new and better environment, managed to organize their affairs for the great trip to the country across the ocean, and were definite enough to break away from the traditions and inertias of life at home. So all the emigrants, whether of high or low I.Q., emotional or reserved, educated or not, skilful or clumsy, all are intrinsically, by definition, of a more controlling than contemplative trend of mind.

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[1] To avoid possible confusion, it may be advisable once more to emphasize that the study of Dewey's logic here means, not the study of the logical theories of Dewey or of his ideas on thinking and Logic, but the study of his actual thinking as it is expressed in his writings.

Then, after coming here, all of them meet the problem of building a new environment, choosing their new homes, buying new furniture, making new friends, often mastering a new language and learning a new trade or profession, whereas in the old country nearly everybody is born into an environment already established, where he inherits everything already considerably fixed, and where in many cases he lives all his life without even being quite conscious of his environment and of the possibilities of controlling and improving it. All this certainly stimulates the controlling aspect of our mind, and not the contemplative one Partly as a result of this, partly as a factor of it, the tremendous growth of cities takes place Certain single cities have grown in a manner without precedent, at an almost feverish and dangerous rate, and the total city population also increases very rapidly As a result of this, fifty-four per cent of the people of this country live in cities (1920) Everybody knows that city life generally, and American city life in particular, does not at all favour contemplation There is small wonder, therefore, that American civilization has become an embodiment of the controlling spirit of the human mind The growth of technique generally, electrification, means of communication, the use of cars and wireless, agricultural machinery, and all kinds of comfort-bringing devices—all these speak for themselves. Even the strongholds of contemplation, religion and art, are invaded by the controlling and active spirit Progressive clergymen discuss "Democratization of God," "Co-operation with God," which sound so strange to European ears. Religious notices in Saturday papers constantly speak of "success," "will-power," different "cures" and "paths to prosperity." Preachers mostly choose for their sermons problems of a definitely controlling trend and acute current social issues In music, America has expressed itself in jazz, which is practically the least contemplative form of music, and the form most charged with dynamism and motion. For the great majority of people, fiction and drama dissolve into movies, which even philologically emphasize dynamism and action. Coming to science, it is idle to dwell on the wonderful progress made in technique and invention, which is so obvious and well known. To mention the name of Thomas Edison would be enough. But the fact that America is now in many respects a leading country in the field of education is worth emphasizing. It is leading not only in its unshaken faith in the controlling power of education, which so forcibly strikes all incoming foreigners,[1] but also in the scientific organization of education, both in theory and in practice. It is remarkable that in the content of educational leadership, America again puts forth action and control; the new school is certainly, to use a very expressive French term, "l'école active."

The great contribution of American science,[2] psychological measurements, is certainly a manifestation of this quantitative controlling spirit. So, too, is the other original American achievement in psychology, Behaviourism, of which its leader, J. Watson, definitely says: "Behaviorism's primary contention is that . . . *if organised society decreed that the individual or group should act in a definite, specific way, the behaviorist could arrange the situation or stimulus which would bring about such action (control)*."[3]

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[1] For instance, H. A. L. Fisher, the British Minister of Education during the War, in an Address at the Annual Conference of Educational Associations in London said, telling of his impressions of America: "America was a land of many churches and one creed; all Americans believed in Education, and the events of the last fifteen years had not contributed to shake America's faith. . . . One of the reasons which confirms the American in his faith in Education is that he recognizes in schools and colleges a unifying force which makes out of the heterogeneous amalgam of races a single people and a single national consciousness." (*The New York Times*, January 7, 1925.)

[2] While intelligence-measurements were started in France by Binet (about 1908), nevertheless the whole present technique, and especially the practical applications of these measurements (in the army during the Great War and in education) are decidedly the accomplishment of American psychologists.

[3] J. Watson, *Psychology from the Standpoint of a Behaviorist*, Philadelphia and London, 1919, p. ix (Preface signed J. B. W.)

It was only natural, therefore, that when the American spirit came to express itself in the largest synthesis of itself—in philosophy—it created Pragmatism, whose essence may be stated as an evaluation of everything on the basis of its controlling, active power.

This brief excursion into the characteristics of American civilization will probably be satisfactory enough to justify the above statement that it is not by accident that the writings of Dewey bring so much light to the problem of dynamic Logic. His philosophy—critical, radical empiricism—is a direct outgrowth and further development of pragmatism, or even, to express it better, is a particular form of it, and therefore presents the broadest generalization and the highest concentration of the modern controlling and dynamic spirit. It is safe to say that his *Democracy and Education* is the most influential single modern book on education This holds beyond doubt for America, and is true for other countries as well. What is the source of its influence? Does it present new facts or discoveries? No. Does it introduce entirely new concepts or problems? Again, not very many. But, then, what is the secret of its power? It is the new and excellent organization of the ideas and the new method of attacking problems involved To see it better, we shall first analyse from this point of view Dewey's pamphlet *Interest and Effort in Education*.[1] In this work, dealing with only one problem, and that a fairly definite one, it is easier to see the characteristic features of Dewey's logic.

The essay begins with a presentation of "the educational lawsuit of interest versus effort" in the form of the briefs of plaintiff and defendant. In other words, we are first given the typical and representative discussion of an educational problem such as everybody connected with education has heard so often. It makes no difference what the particular problem in question is, but the general procedure, the spirit of reasoning, is in most cases exactly as it is pictured there.

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[1] John Dewey, *Interest and Effort in Education*, New York, 1913

"In the educational lawsuit of interest *versus* effort, let us consider the respective briefs of plaintiff and defendant In behalf of interest it is claimed that it is the sole guarantee of attention; if we can secure interest in a given set of facts or ideas, we may be perfectly sure that the pupil will direct his energies toward mastering them; if we can secure interest in a certain moral train or line of conduct, we are equally safe in assuming that the child's activities are responding in that direction, if we have not secured interest, we have no safeguard as to what will be done in any given case. As a matter of fact, the doctrine of discipline has not succeeded. It is absurd to suppose that a child gets more intellectual or mental discipline when he goes at a matter unwillingly than when he goes at it out of the fullness of his heart. The theory of effort simply says that unwilling attention (doing something disagreeable because it is disagreeable) should take precedence over spontaneous attention.

"Practically the appeal to sheer effort amounts to nothing When a child feels that his work is a task, it is only under compulsion that he gives himself to it. At every let-up of external pressure his attention, released from constraint, flies to what interests him. The child brought up on the basis of 'effort' acquires marvelous skill in appearing to be occupied with an uninteresting subject, while the real heart of his energies is otherwise engaged. Indeed, the theory contradicts itself. It is psychologically impossible to call forth any activity without some interest. The theory of effort simply substitutes one interest for another It substitutes the impure interest of fear of the teacher or hope of future reward for pure interest in the material presented. The type of character induced is that illustrated by Emerson at the beginning of his essay on *Compensation*, where he holds up the current doctrine of compensation as implying that, if you only sacrifice yourself enough now, you will be permitted to indulge yourself a great deal more in the future; or, if you are only good now (goodness consisting in attention to what is uninteresting) you will have, at some future time, a great many more pleasing interests—that is, may then be bad.

"While the theory of effort is always holding up to us a strong, vigorous character as the outcome of its method of education, practically we do not get such a character We get either the narrow, bigoted man who is obstinate and irresponsible save in the line of his own preconceived aims and beliefs, or else a character dull, mechanical, unalert, because the vital juice of spontaneous interest has been squeezed out.

"We may now hear the defendant's case Life, says the other theory, is full of things not interesting that have to be faced Demands are continually made, situations have to be dealt with, which present no features of interest Unless one has had previous training in devoting himself to uninteresting work, unless habits have been formed of attending to matters simply because they must be attended to irrespective of the personal satisfaction they afford, character will break down or avoid the issue when confronted with the serious matters of life Life is not a merely pleasant affair, or a continual satisfaction of personal interests There must be such continual exercise of effort in the performance of tasks as to form the habit of dealing with the real labors of life Anything else eats out the fiber of character and leaves a wishy-washy, colorless being, a state of moral dependence, with continual demand for amusement and distraction

"Apart from the question of the future, continually to appeal even in childhood days to the principle of interest is eternally to excite, that is, distract the child Continuity of activity is destroyed. Everything is made play, amusement. This means over-stimulation, it means dissipation of energy Will is never called into action. The reliance is upon external attractions and amusements. Everything is sugar-coated for the child, and he soon learns to turn from everything that is not artificially surrounded with diverting circumstances The spoiled child who does only what he likes is an inevitable outcome.

" The theory is intellectually as well as morally harmful Attention is never directed to the essential and important facts, but simply to the attractive wrappings with which the facts are surrounded. If a fact is repulsive or uninteresting, it has to be faced in its own naked character sooner or later Putting a fringe of fictitious interest around it does not bring the child any nearer to it than he was at the outset The fact that two and two make four is a naked fact which has to be mastered in and of itself. The child gets no greater hold upon the fact by having attached to it amusing stories of birds or dandelions than if the simple, naked fact were presented to him It is self-deception to suppose that the child is being interested in the numerical relation His attention is going out to and taking in only the amusing images associated with this relation The theory thus defeats its own end It would be more straightforward to recognize at the outset that certain facts, having little or no interest, must be learned, and that the only way to deal with them is through effort, the power of putting forth activity independently of any external inducement In this way only is the discipline, the habit of responding to serious matters, formed which is necessary for the life that lies ahead of the child "

Really this is a very expressive sample of the old logic. Both parties emphasize the fundamental difference, the radical opposition and the mutual exclusiveness of interest and effort. They try to put a most definite, a most insurmountable division line between them to separate them as far and as completely as possible, and to prove that any really efficient school must be based either on interest, solely, with complete expulsion of effort (the interest theory), or exclusively on effort without any destructive influence from interest (the discipline theory). The general trend of each idea is to separate and to exclude itself from everything else Putting it into the symbolic language of a generalization, it is a very clear case of heralding the law " A is B but by no means non-B "

Then the author remarks that " the strong point in each argument lies not so much in what it says in its own behalf as in its attacks on the weak places of the opposite theory " (p. 16) As we shall see a little later, it could not be otherwise, because each theory, being one hundred per cent exclusive, cannot successfully cope with the whole complex situation, and therefore the only way for any positive achievement is for each of them to negate the negative sides of the other

Then Dewey starts to introduce his correction of this kind of reasoning. In the course of the essay we shall see many of these corrections (the whole discussion, in construction and spirit, is practically one continuous correction), and all of them are of the same kind, that is, the establishment of continuity between different concepts and judgments, and the abolition of separation between them. The following quotations will not only illustrate how critical the essay is, but will also indicate the direction of the criticism " The phrase is a misnomer " (p. 11) " The error lies . " (p. 18) " Error begins . ." (p 19). " Two thoroughgoing errors . ." (p 98) " The true relations . . ." (p 98) " Properly conceived . . " (p. 97). " The great fallacy of so-called . . ." (p. 7) " The false ways of understanding . . " (p 41). " At bottom all misconceptions . . ." (p. 90), etc. The author does not introduce new facts, nor any definite theories. He is concerned only with the correction of " fallacies," " false ways of understanding," and " misconceptions," of wrong ways of thinking, generally. His reconstruction is purely logical, and it is worth while to notice that it reveals mistakes, not of any single definite thinker, but of our modern current reasoning in general. Three names only, Pestalozzi, Froebel, and Montessori, are mentioned, but not in connexion with the main issue, and the criticism of their ideas is exactly the same as all the other corrections of false thinking

Actually, all problems and difficulties of discussion are solved by one and the same method, by annihilating separation and gaps between the concepts or judgments involved and by establishing continuity between them. This is the fundamental principle underlying the whole essay and running like a *Leitmotif* from the beginning to the end. Even a formal analysis of the vocabulary of the essay shows a predominance of the continuity-separation idea. In the ninety-six small pages of the essay this idea, in one form or other, is used about one hundred and forty times to reveal misconceptions and wrong ways of treatment of our intellectual activities As might be expected in a critical essay, the negative aspect of the idea is used oftener. Separation is condemned about ninety-five times against forty-five cases of emphasis on continuity. The most frequently used form is the idea of "externality" and "external"—thirty-four times, probably because it so definitely conveys the idea of a distinct borderline Next follows " division "—eleven times and then—

isolated (or isolation)	8
separate, etc	7
apart	6
abstract	6
gap	3
alien	3
cut off—away—up	3
divorced	2
bare	2
remote	2
outward	2
independent	1
disconnected	1
detached	1
by itself	1

The leading expression for "continuity" is a very strong one. It may be even too strong if taken objectively, but tactically it is very efficient, stressing the idea of continuity versus separation in the most definite way possible. It is "identification" (identify, identical, etc.)—eleven times. Then follow—

connection and interconnection	10
continuous, etc.	5
intrinsic	3
unified	3
one, single, whole	3
internally	1
permeate	1
included	1
no sharp distinction, absorbed and other miscellaneous	8[1]

How the continuity-separation idea helps in reasoning, a more detailed analysis of the essay will show. Facing the first problem, whether interest or effort secures the better efficiency, Dewey indicates that the difficulty in the problem is not a real one but the result of a misconception, of a false assumption, underlying the whole discussion. The difficulty is of the same kind as that required to answer the question, "How much would 5 by 7 be, if 3 by 3 were 8 ?" Remove the false assumption, and the puzzling problem would cease to exist. In this case the fiction is the assumption that interest and effort are separated entities, mutually exclusive. If we go back to reality, to first-hand experience, we shall easily see that, quite on the contrary, both of them are complementary and, in a certain sense, inseparable aspects of the one broader thing, activity. They cannot even exist one without the other. Thus, as soon as opposition and separation are replaced by identity and continuity, the problem, which to accept and which to discard, at once disappears, and we accept both. Summarizing his discussion on interest, Dewey says:

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[1] In both tables all words are counted only if they are used to indicate the right way to interpret and guide human activities.

"Wherever there is life, there is activity, an activity having some tendency or direction of its own . . . The condition either of total lack of interest or of impartially distributed interest, is as mythical as the story of the ass in scholastic ethics" (p. 19). On the other hand, "what is it that we really prize under the name of effort? . . . What we are after is *persistency, consecutiveness* of activity endurance against obstacles and through hindrances . . . The demand for effort is a demand for *continuity* in the face of difficulties" (pp. 46, 47). And this means that any activity (if it is not a momentaneous explosion which cannot properly be called activity) having consecutiveness and continuity by the mere fact of its existence involves effort in one or the other degree, and cannot be conceived without it. Furthermore, Dewey says "For the sake of completeness of statement we will say (what hardly should now require statement on its own account) that such [intelligent and rightly understood—B. B. B.] effort is in no sense a foe of interest" (pp. 58-59). Thus the whole problem is practically solved by ceasing to speak of effort and interest as opposite to each other, and discussing instead a unified activity which Dewey prefers to call a "genuine interest" ("our first conclusion is that interest means a unified activity," p. 15), though from the point of view of sheer Logic it could be equally well called "genuine effort," because it would signify the continuous, unified activity as well as genuine interest (pp. 46, 47).

The striking difference between the new logic and the old conventional logic is best seen when one realizes the controlling function of the argument in question. If a person of the old logic sees a child engaged in a certain activity, the first question for him will be whether the activity is one of effort or of interest, and the more active and successful he is in his reasoning, the more he will separate the given activity from either the idea of interest or the idea of effort And naturally in his educational guidance he will always try to separate the interest-elements and effort-elements as completely as possible, and do his best to eliminate one of them as thoroughly as he can. In his reasoning and action he will embody the law "A is B but not non-B." The person of dynamic logic, observing a child engaged in a certain activity, will understand that both contrasting elements—interest and effort—are always present in any activity, and in his attempt to help the child in its growth he will try to unite, harmonize, and balance them in such a way as to make the activity of the child the most efficient and satisfying possible. In his reasoning and action he will be guided by the principle "A is B and non-B at the same time."

Analysing the situation deeper, Dewey shows further that the fallacy of separation of interest from effort is the direct consequence of two other mistakes of the same type; the separation between actor and object acted upon on the one hand and between consecutive steps of the same activity on the other hand. "Effort, in the sense in which it may be opposed to interest, implies a separation between the self and the fact to be mastered or task to be performed, and sets up a habitual division of activities" (p 14) "Interest, in the sense in which it is opposed to effort, means simply an excitation of the sense-organ to give pleasure, resulting in strain on one side and listlessness on the other" (p. 14) "The result [of this kind of pleasure—B B B] is a division of energies In the case of disagreeable effort the division is simultaneous. In this case it is successive" (p. 13)

The two samples of the fallacy of separation are of very great importance if taken as an illustration of the two most important divisions of the fallacy. We may contrast, distinguish, separate, and make mutually exclusive two ideas or two facts because of the difference in their nature or spatial position. In this case the element of time does not play any part, at least not at first sight.

Neither does the factor of change or motion seem to be involved. Work and play, subject-matter and method, individual and environment, are the pairs which illustrate that kind of opposition and separation, which may be called, for the time being, spatial and static separation

The other kind of separation is where time, change, and motion obviously play the most important part. This is the separation of any process into artificial, fixed sections. Dewey describes the nature of this kind of separation, in the case of interest, in these words: "At bottom all misconceptions of interest, whether in practice or theory, come from ignoring or excluding its moving, developing nature; they bring an activity to a standstill, cut up its progressive growth into a series of static cross-sections" (pp 90-91). Such treatment of any change or motion or process always leads in one or another form to a flat contradiction to reality, as has been shown in more detail in the earlier discussion of sophisms. Cause and effect, means and ends, child and adult, a moving arrow, activity without any interest at all and activity made interesting are illustrations of that kind of separation which may be called dynamic and temporal separation If we now look at the two kinds of fallacies from the point of view of the positive aspect of the separation-continuity idea, we shall see that actually both cases are closely related to change and motion. The necessity of the continuity principle for the correct understanding of processes and changes has already been mentioned many times What must now be set forth is the fact that continuity between concepts or facts, previously considered separated by space or by nature, requires also a certain unification of them, the annihilation of distance between them, a reorganization of the relationship of the concepts, or in other words, certain changes in and, so to speak, *motion* of our thought. If the facts do not unify themselves before, as by continuous motion, then, in order to connect them, we have to move. If a mountain does not come to Mohammed, he himself must go to the mountain.

Thus where there is continuity there is flux, change, motion in one or another form, and therefore the logic of continuity may be quite properly and exactly called dynamic logic. From this point of view, the positive correlates to the above-mentioned (*a*) separation in space or nature, and (*b*) separation in time, may be designated as (*a*) continuity of co-existence, and (*b*) continuity of process. On the other hand, the fallacy of separation may be viewed very often as a fallacy of considering concepts and facts static, fixed, unchangeable, completely finished, or perfectly accomplished, and not dynamic, flexible, changing, transitional, and capable of further development.

Returning to the analysis of *Interest and Effort* we see that the whole discussion is one continuous application of the same method, a pair of contrasting concepts are taken and they are proved to be, not separate and mutually exclusive, but continuous and of the same kind (See Appendix, p. 259f)

This analysis of the essay shows the remarkable consistency with which the same logical method is used and not the less remarkable efficacy which it possesses. A similar analysis of *Democracy and Education*, or *Human Nature and Conduct*, or *How We Think*, would show the same extensive use and high efficiency of the method [1]

Let us now sum up the essence and technique of the method of the new reasoning It is rather uniform in its operation. The problems are attacked and always solved or, rather, disposed of in the same way. When the problem is presented and difficulty is felt, the first step is to find two contrasting concepts which lie at the bottom of the difficulty in question, such as mental and physical, dislike or longing, work and play, and others Then, in the light of the contrasting concepts, it is usually easy to see that the difficulty arose when a certain real situation was judged in terms of the contrasting or contradictory concepts or, in other words, when it was attempted to establish a relationship between the situation and the concepts. Usually, in one wording or another, the problem is "Which of the two concepts covers the situation in question, and which is outside it?" For instance, is walking a mental or a physical activity? Is an effort a manifestation of dislike or of longing? Is mathematics a practical or a theoretical discipline? Is tennis work or play? And then comes the most important moment of the whole procedure. It is shown that the two contrasting or contradictory concepts are really not mutually exclusive as tacitly assumed, but are continuous and inseparable. In other words, it is shown that the problem itself, let us say, "Is an effort a manifestation of dislike or longing?" is only a product of some fundamental misunderstanding. Actually an effort is a manifestation both of dislike and of longing, and walking is both a mental and a physical activity. The problem is solved, or, in other words, it is not solved, but removed. In a certain sense it is even better than solved, because in the form first presented it is now for ever put aside, with not even a chance of being again brought up for reconsideration And in that power of "killing" problems lies the secret of the success and growing popularity of the new logic.

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[1] The range of the problems discussed and of the categories involved is indicated by an incomplete list of the categories given in the Appendix (p 257f). The concepts listed are all treated in accordance with the continuity-separation principle in the works mentioned above.

But, while "killing" the problems in the present formulations, the new logic, without further modification and development, at the same time introduces new problems which are probably no less grave than the old ones, especially from the point of view of the control of environment. If we overdo it, and invariably smooth out all differences, giving to any question "Is this A B or non-B?" the one and only answer of "both," we shall lose the ability to make any differentiation. We shall then make all organization of experience impossible, and reach the conclusion, probably very true but pragmatically useless, that "everything is everything" In other words, we shall reach the very formula, "A is A," which is the foundation of the old static Logic. If, indeed, any activity is both mental and physical and no more, then there is no difference in the mental and physical characteristics of "a lecturer sitting in his chair and organizing his thoughts for to-morrow's speech" and "a professional strong man lifting half-a-ton in a circus." But beyond doubt a difference actually does exist If we merely say that mathematics is always both practical and theoretical, how shall we detect a difference between "counting how many silver spoons have been stolen from the cupboard" and "calculating the 706th decimal place of π" or "constructing non-Euclidean geometry"? But, again, a difference does exist in reality, and it is a very great one. To find the way out of the situation, we have only to apply the same logical method to the problem, or, in other words, to apply the new logic to itself The old logic regarded the contrasting concepts as almost entirely, or one hundred per cent, different and exclusive. The new logic has a tendency to consider them to be very much alike, even identical Dewey, discussing interest, emphasizes very strongly the identity of an actor and the object of his action Identity is a very strong word. It is very good to use it to counterbalance the old tendency to isolate concepts, but it cannot be used in the absolute, exclusive one-hundred-per-cent sense. We must never forget that "A is B and non-B" at the same time. Concepts are different and identical at the same time. They tend to separate and to unite simultaneously. In any particular case of judgment we cannot be satisfied with answering the question whether A is B or non-B, by saying merely that A is both B or non-B, but we need to know to what degree A is B and to what degree non-B. Without that we cannot see the real meaning of the situation. In other words, we have to use certain definite quantitative indices in our judgments It is not very illuminating to insist that lifting a weight by a strong man is one hundred per cent physical activity or one hundred per cent mental activity, but it is also pragmatically useless and ineffectual just to accept that it is both physical and mental without any further modification. In order to distinguish it from other mental-physical activities, we have to know to what extent it is mental and to what extent it is physical. We have to recognize that without quantitative indices our reasoning cannot have any pragmatic, controlling meaning, if any meaning at all. Thus the general formula for our thinking must be: "A is B to such a degree and non-B to such a degree."

Before examining the practical implications of the formula and suggesting a workable technique for its application, we have first to organize our ideas about reasoning and Logic generally by the method and in the terms of dynamic logic As long as we treat the process of reasoning and its products in the spirit and letter of the old static logic, separately, as if they were cut into arbitrarily chosen static units, it is impossible to see their real nature or to formulate any efficient technique of productive thinking.

CHAPTER V

PRINCIPLES OF DYNAMIC LOGIC

To test Reality we must see it on the tight-rope. When the Verities become acrobats we can judge them.—OSCAR WILDE

IN our reasoning about reasoning the fallacy of separation plays no less a part than anywhere else, and it is here especially harmful because there are few processes so flexible, so dynamic, and so continuous as our thinking. Consequently the old static logic nowhere applies so little as here. Among many separations which must be abolished before any fruitful discussion of reasoning can take place, one of the most important and convenient to start with is the contrast between Logic and the psychology of reasoning. They are differentiated usually by the two following qualifications: the psychology of reasoning is supposed to be interested (*a*) in the process of reasoning, and (*b*) in all forms and kinds of reasoning, while Logic is concerned with (*a*) the products of reasoning, and (*b*) only in the correct forms of reasoning which result in truth.

The first distinction introduces a more general problem, that of the separation of a process and its product, the result. The separation is quite artificial and the difference between process and product is only in degree, or, to be more precise, in the rate of change, and not in kind. The product is only one stage of the process in question—a stage which we, for one reason or another, want to emphasize, or in which we are more interested than in others. On the other hand, the process itself is nothing else than a succession, a continuum or a total of many different "products," or in other words, of many different stages of itself. For instance, we call "cider" the product of the process of the fermentation of the apple juice. We choose to call this special stage of the whole process the product, because from our point of view it is the most valuable stage of all; but intrinsically, in kind, cider is neither more nor less the product of fermentation than is the juice which just started to ferment, or the vinegar into which cider will develop, or any other stage of the fermentation At any given moment any bit of the organic matter which we call cider or apple juice is both the process and its own product. Generally speaking, when we observe any continuous change long enough to make the elements of difference more conspicuous than the elements of identity, we call the unit of experience a process If we observe it for only a short time, so that the elements of identity outweigh the elements of difference, we call that unit of experience a product of a certain process. But in both cases the difference is not in kind but in degree, not absolute but relative to the time involved Sometimes it is relative not to time directly but to the rate of change or velocity in the process. For instance, in one continuous process of change suffered by a certain amount of matter, when a piece of steel is produced from ore, we call the steel the product of the metallurgic process, probably not only because steel is so useful, but also because the rate of change taking place in steel is much slower than in other and previous stages. But again the difference is only in degree and not in kind. Both steel and melting ore are processes in a broad sense, differing only in rate.

From this general point of view the "products" of reasoning, which Logic studies, differ from the "processes," with which the psychology of reasoning deals, only in degree. They are processes also, but their rate of change is very slow. From this point of view Logic is only a particular part of psychology—the psychology of reasoning which studies thinking processes which have a very low rate of change

The other differentiation between psychology and Logic, made on the basis of correctness of reasoning or truth, is obviously only relative. There are very few, if any, statements which are one hundred per cent perfectly correct or one hundred per cent truth, no matter what definition of truth we are inclined to accept. Even the most rigorous and precise reasoning of mathematics is described by B. Russell as: "the science in which one never knows what one is talking about nor whether what one says is true."[1] This is no mere joke or sensational gesture without any reasons behind it. On the other hand, nothing that can be called reasoning is entirely and completely devoid of logic. The mere succession of different entirely disconnected mental images which sometimes takes place in wild dreams or in the mental processes of insane people or of persons in the grip of a very high fever—all this is not reasoning, and therefore cannot be included in the psychology of reasoning. Thus, from the point of view of the subject of their study, the psychology of reasoning and Logic have the same domain and are not separated by any insurmountable border. The established continuity between Logic and the psychology of reasoning will enable us to apply many generalizations of the latter to the former and to treat logical units, not as unchangeable static entities, but as flexible, dynamic processes.

The next separation to be removed is the contrast between perception and conception, or between experiencing without meaning and experiencing with meaning. It is fairly obvious that actually there is no such thing as a pure one hundred per cent perception. Reasoning may mean many other things, but, no matter what definition of it we accept, it always conveys the idea of a certain connexion between a particular bit of experience and a certain larger amount (if not the whole) of one's previous experience, stored and organized by our mnemonic capacity, and because we cannot think of any particular experience as completely isolated from all other experiences, we cannot think of any perception without a certain element of conception in it. Dewey in his *How We Think* takes as an illustration of the perception-conception a common experience which a certain man, A, expresses in the words, " I saw my brother." Dewey remarks that the term " brother " involves a relation which cannot be sensibly or physically observed. " If A would refer to the experience in the words ' ' I saw a man,' the factor of classification . . . still exists." " If as a last resort, A were to say ' Anyway, I saw a colored object,' some relationship, though more rudimentary and undefined, still subsists "[1] Even in such low levels of mentality as that of a new-born child or those of lower animals, immediate experiences are always coloured with a certain element of classification : they are either desirable and attractive or undesirable, repulsive Rignano believes that " all animals, from the lowest upwards, are capable of such affective classification,"[2] and in it he sees the root of all our conception and of all our abstract thinking Pillsbury, taking as an illustration our experiencing of a table-top, calls attention to the fact that under usual conditions everybody " sees " it as a rectangle and not as a trapezoid or rhomboid as it really looks, and concludes that " in perception as well we are conscious of nothing but type, of nothing but meaning "[3] Further on, he states even more definitely : " All perception, then, as well as all thinking, is in terms of the meaning rather than in terms of crude discrete memory images "[4]

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[1] Quoted from Keyser, *Mathematical Philosophy*, p 133

On the other hand, there are no concepts completely detached from immediate experience. The old saying, " Quod non in sensu non in intellecto," now looks even truer than before. Rignano defines reasoning as a mental experimentation or " a series of operations or experiments simply thought of."[5] To him, " the logical process appears, then, to be identical with the perceptual reality itself, operated solely by means of the imagination instead of activity" "Far from losing contact with reality for a single instant, reasoning relies on the solid ground of the real in each phase of its development."[1] Having established a quite definite continuity from the above-mentioned "affective tendencies" to the most abstract mathematical reasoning, Rignano concludes · "This rapid but, at the same time, perhaps too lengthy excursion into the field of the higher forms of reasoning appeared to us necessary, in order to bring clearly into evidence that the fundamental nature of reasoning, as a series of merely imagined operations or experiments, remains without change even in cases where an abstractness pushed to its extremest limit and an excessive complex symbolic form might at first sight succeed in concealing or even disguising the fact"[2]

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[1] *Op cit*, p 86.

[2] E Rignano, *Psychology of Reasoning*, New York, 1922, p 105

[3] W Pillsbury, *The Psychology of Reasoning*, New York, 1910, p 85

[4] *Ibid*, p 87.

[5] *Op. cit*, p. 87.

Thus we see that in reality there is no separation between conception and perception. Every and any bit of experience always is both perception and conception or, in other words, is a peculiar combination of particular and general. The same phenomenon of fusing together a smaller unit of experience with a larger one, or probably with one's whole experience looked at from slightly different angles, introduces problems of concrete versus abstract, objective versus subjective, facts versus judgment of them, stimulus versus response, individual versus environment, and so on. Because all the pairs are only different interpretations and expressions of the same situation, all of them are as continuous as the perception-conception pair, and in reality we can hardly ever meet anything one hundred per cent pure "concrete," or "stimulus," or "fact," or whatever it is

To make this clearer, a few illustrations of the objective-subjective pair will perhaps be helpful. For most of us a good photograph is supposed to be something quite objective, but the writer's experience with peasants in certain sections of Russia shows that not everybody can "see," for instance, a house or a group of people on a photograph. Sometimes peasant women could not recognize what were quite good pictures, and even tried to look at them upside-down. For an average New Yorker, the adventures of Mutt and Jeff or "Spark plug" are quite plainly "seen" in the comic sections of periodicals. He "sees" at once when Mutt is happy or Jeff in despair, but for foreigners of equal education and culture it takes sometimes weeks of training to "see" all that may be "seen" in the cartoons On the other hand, Binet has demonstrated experimentally that even in cases of almost exclusively subjective phenomena, like hypnotic, post-hypnotic, hypnagogic, and toxic hallucinations, the starting-point, the centre of crystallization, as it were, is very often a certain objective stimulus [1]

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[1] E. Rignano, *Psychology of Reasoning*, 63

[2] *Ibid.*, p. 207.

All the above-mentioned pairs refer to one central fact, which is very important as the real essence of reasoning, and which may now be more precisely described as the connecting of a new experience with the larger conglomerates of previous experiences, or with the individual experience as a whole The word "new" here means not so much "new in content" as "new" or latest in temporary order, as, for instance, we call certain fashions "new" if they have just been adopted by ladies, even though the fashion is in its content an almost identical imitation of Egyptian or Roman fashions. Thinking of the connexion of new and old experiences, we always have to keep in mind that it is a highly continuous process, more like biological growth or a chemical reaction, and not like a mechanical combination of different separate parts One of the most fundamental mistakes of the old classical Logic was that it considered the connecting of new and old experiences—as for instance, in the syllogism—something like finding arithmetical sums. We have the augend 3 and addend 4, and then comes the sum 7 The "3" as a number is something completely static and eternal, and so is "4," and they would continue to exist after the sum 7 had come into existence, exactly as they were before "All men are mortal. Socrates is a man. Therefore Socrates is mortal" That last conclusion, supposed to be a result of a certain interaction of the former propositions, does not at all change them by its coming to being. Before the inference there were two propositions; after it their number increased rather mysteriously into three, but the first two did not suffer any change. In real thinking the conclusion really grows from both new and old experiences or, better, is both of them combined, so that if we go back to any one of them we shall see it changed, because of its participation in the process of inference.

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[1] A Binet, *The Psychology of Reasoning*, Chicago, 1899, pp 37 ff., 137, 129 ff., 133 ff

But the process of reasoning cannot be satisfactorily understood if we neglect the quantitative aspect of it. In the process of the unification of the new and old experiences, there may be different ratios in different cases between the efficacy or power of the new experience and the old one. Both of them are always modified as a result of their union, but if, for instance, the old one is more powerful than the new, then the new experience will be changed more, and in this case we are very often apt to see the changes in the new experience only. On the contrary, if the new experience is more powerful and has a greater mass, as it were, we shall be inclined to see changes only in the less massive old experience. This leads us to the problem of the deductive-inductive aspect of reasoning. The old Logic differentiated definitely between them. Deduction was considered as an application of the general principle to a particular case and induction as the opposite process of constructing a general rule from particular instances As the movements run in quite opposite directions, they were even thought to be mutually exclusive for any single operation of reasoning. But, as a matter of fact, we always have, in any act of thought, both deduction and induction, only under certain conditions we have the inductive element predominant, in other circumstances the deductive tendency prevailing.

An illustration in the form of judgment—the most representative (or, more precisely, from a certain point of view, the only existing) act of thought—will make the statement more concrete and explicit The Board of Administration of a Painting Exhibition in New York requested every visitor to choose the best picture in his or her opinion, and promised that the painting which received the majority of votes would be announced as the most popular one. The situation is a very clear case of judgment. We have the old experience (the general artistic and critical background of the public), the new experience (an appreciation of the pictures of the Exhibition), and, as a result of their interaction, the judgment as to the best picture The organizers of the Exhibition probably had also in mind another purpose in starting the voting—namely the education of the public. But whether they actually thought of it or not, certainly both processes—the valuation of the pictures and the æsthetic growth of the public—took place simultaneously But under different conditions the relative weight of the two processes could be different If the public happened to have rather an extensive and well-organized previous æsthetic experience, and if, for their part, the pictures were artistically very insignificant, then the decision of the public would be very reliable, but the change in their capacities for artistic appreciation would be very slight Here we should have a clear case of so-called " deduction " But if the pictures happened to be very refined and of great artistic value, and if, on the other hand, the public had a very poor æsthetic background, then the verdict of the public would not be anything like as reliable, but the advancement of their æsthetic abilities as a result of their experiences in the Exhibition would be considerable. This case could be called a typical " induction " Strictly speaking, in both cases, as always, both inductive and deductive processes participate, because in reality they are not exclusive but, on the contrary, as inseparable and complementary as the N. and S. poles of any magnet.

The other aspect of the process of reasoning, also quantitative, is the rate of speed with which the process goes on. This brings in the problems of apprehension versus comprehension or "intuition versus reflective reasoning," to use Rignano's terminology. We know that reasoning starts with doubt, or difficulty, or feeling of lack of continuity between the new experience and the old one, and that it terminates in belief, or feeling of harmony, or continuity of the two experiences[1] When the reasoning proceeds very quickly, and the change from doubt to belief is nearly instantaneous, so that we hardly have a chance to feel the problem attitude, then we have apprehension or intuition If the reasoning goes on rather slowly, so that we can distinguish many intermediate stages, then we call it comprehension or reflective thinking[2]

It is easy to see that there is not, and cannot be, any sharp discriminating line between the two kinds of thinking Obviously there is a continuous series of different examples of reasoning from intuition, quick as lightning, to a very slow and even clumsy process of methodical and detailed reflection The education of Dr Watson in Conan Doyle's famous detective stories (if he was capable of education in this respect) could provide a good continuous series in question Mr Sherlock Holmes really "saw" that a certain gentleman had just come from India, or that a girl visitor was a typist by profession, or that Dr Watson was thinking about the last sensational murder case, and so on, but Dr Watson could reach the same conclusions only after careful deliberation, if at all. An experienced mathematician sees that the acute angle of a right-angled isosceles triangle is equal to 45°, but the neophyte in geometry realizes it only after considerable reflection. An American, when he smells a specific odour, would say at once, "Well, there is a skunk somewhere around," but a foreigner, to realize the meaning of this peculiar smell, would probably need to carry on real research—investigating where the smell definitely came from, remembering everything that he knew about animals, asking other people or consulting books, and so on. The "Americanization" of the foreigner in this respect, or the growth of mathematical insight in different students of geometry, could again supply intermediate steps in the continuum between the immediate and reflective understanding.

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[1] Cf Dewey, *How We Think*, and C S Pierce, *Chance, Love and Logic* (The fixation of belief), London and New York, 1923

[2] Strictly speaking, there is a difference between the apprehension-comprehension and intuitive-reflective thinking concepts Apprehension means instantaneous establishing of continuity between new and old experiences immediately upon presentation of the new experience Intuition covers events of this kind plus cases wherein the presentation of the problem is followed by a rather long period of doubt and then at once, like a flash, the solution comes

The last separation to be replaced by continuity, before we go on further, is the separation between the different static units into which the old formal Logic dissected the process of reasoning. They are terms (or concepts), propositions, and syllogisms. First of all we shall look at them, not as static units, but in their dynamic aspect, as processes of a very low rate of change. Then the proposition will become judgment of low velocity and syllogisms will be inferences of low velocity. As far as the specific nature of terms is concerned, it is very difficult to think of them outside of judgment. As independent units they exist, if anywhere, only in quite incoherent dreams and extreme cases of insanity. Even if thought of independently of any definite problem, they always come to our mind in the form of statements, in other words, of propositions: a table is so and so; man is so and so; biology is so and so, and the like. Consequently, they are actually only a specific kind of proposition, and from this point of view they may be regarded as a specific kind of judgment, namely, as definitions having a very slow rate of change. With this modification, practically only one separation is left—judgment versus inference That judgment and inference have much in common, is obvious at once There are certain pieces of reasoning which certain logicians classify as judgment, and other logicians classify as inference. In his *How We Think*, Dewey says "That there is an intimate connexion between judgment and inference is obvious enough. The aim of inference is to terminate itself in an adequate judgment of a situation, and the course of inference goes on through a series of partial and tentative judgments."[1] But it is possible to go a little further, and to say that every judgment involves inference or even, to express it better, is something like condensed, instantaneous inference On the other hand, any inference is but a piece of highly continuous flux of judgments, so that the relationship between them is of the same kind as it generally is between process and product, as discussed above.

In discussing the apprehension-comprehension problem, we saw how continuously the typical reflective series of inferences may pass to an instantaneous judgment. As a matter of fact, any judgment is a long series of inferences more or less entering our consciousness When, for instance, I am looking at a car, I may express a simple judgment like this. "That is an expensive car" As a matter of fact, I am not judging I consciously or unconsciously pass through a chain of inferences I do not see immediately that the car is expensive, its price is not marked on it. I only see that it is comfortable and powerful, and, knowing that comfortable and powerful cars are expensive, I infer that this car is expensive. But actually I do not even experience the comfort and power of this car. I only see that its front part is very large and everything inside looks soft and roomy, and again, because I know that a car with a bulky motor-part and a roomy and soft-looking interior is powerful and comfortable, I infer that this car is powerful and comfortable. But again, it is not direct simple judgment, because I cannot directly experience that everything inside is *soft*, it only *looks* like that, and knowing how soft anything is which looks like that, I infer my conclusions. It is obvious that it is nearly impossible to reach an end to discovering inferences inside inferences in this way. But again, it is only part of the whole affair. The same analysis is applicable to the term "car," which starts again the long chain of inferences.

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[1] *Op cit*, p. 101.

Binet in his *Psychology of Reasoning* claims that the simplest act of perception always involves inference, to a certain degree.[1] Pillsbury, besides thus digging, as it were, into a single judgment, compared different kinds of judgments and inferences and, after a careful analysis, reached the following general conclusions: "Apparently, then, the three processes of analytic judgment, synthetic judgment, and inference in logic are not to be easily distinguished,"[2] and "the net result of the present chapter is to see that judgment shades over gradually, so far as expression is concerned, from a proposition that expresses a single appreciation and so a single judgment, to propositions that combine two appreciations or some mental addition to the situation, and so constitute an inference in the true sense."[3]

Having thus established the continuity between judgment and inference, and remembering also that we had already established continuity between perception and judgment (p. 100), we now have the complete continuity from the lowest cognitive processes to the most complicated ones. This continuity would allow us to treat all possible phases and manifestations of thought processes as manifestations of something homogeneous, and to make generalizations applicable (probably with certain modifications) to all of them. Though we now think of reasoning as a continuous process, all forms of which are alike in their most fundamental features, nevertheless it would often be necessary to choose certain, so to say, sections of thought process for special attention, investigation, or consideration. We shall, then, call these "units" of thought. As a matter of fact, actually we can never deal with anything but limited parts of any process at any one time; so later, especially when we analyse reasoning in greater detail, we shall, in most cases, deal with the units of thought The term "unit of thought" is chosen here because it denotes precisely what it is supposed to designate and nothing more; namely, just the fact that this particular section of the thought process as a whole, or a unit, is at present an object of special consideration. The term does not suggest anything concerning either the reasons for the particular choice or the peculiarities of the content of the section. There are other terms that stand for almost the same idea, but very often they introduce some additional more specific connotations. For instance, "an act of thought" conveys (though maybe not quite explicitly) the idea of a certain definite aim and achievement, or a certain self-sufficiency of this particular part of the reasoning process, which would be rather misleading and contradictory to the assumption of thorough continuity and uniformity for the flux of thought.

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[1] Ch. iii.

[2] Pillsbury, *The Psychology of Reasoning*, p. 183.

[3] *Ibid.*, p. 198.

This discussion of the thought process may best be summed up and the continuity of reasoning most definitely emphasized, by means of the following formula of reasoning, which takes into account all the factors determining reasoning above discussed. It is as follows.

$$A = \frac{1}{R}\left[(Po + Pn) + (Ni + Nd)\right]^{C},$$

where A stands for any unit of thought in a broad sense or, in other words, any unit of cognitive experience; Po, for previous experiences, pertinent to the doubts at the bottom of the reasoning, stored in one's mind by mneme,[1] and sufficiently organized round the problem in question; Pn, for experiences of the same kind but not sufficiently organized in respect of the problem in question; Ni, for new or present cognitive experience, in its elements identical, as far as possible, with certain previous experiences; Nd, for elements of new experience considerably different from previous experiences, R, for the rate of the fusion of the Po and Ni + Nd; and C, for the degree of complexity of the cognitive unit in question.

In its present form and under our present less than insufficient knowledge of the quantitative side of thought processes, this formula does not pretend to be useful or helpful for any exact quantitative treatment of reasoning processes. The formula does not claim to be exhaustive, nor to take into account all the main features of reasoning. For instance, the part played by imagination and mneme is not presented by any special symbol Probably the previous experiences are not differentiated enough, and so on. But it may be useful in many other respects. Although not able to lead us to any definite calculations, it nevertheless inevitably directs our attention to the quantitative aspect of reasoning, to the relationship and approximate ratio of influence of the different factors involved Then it certainly would ensure us against the mistakes so common in our scientific thinking, that is, against one-sided interpretations and unwarranted generalizations One of the chief sources of confusion in the study of the thought process, as well as in most other humanistic disciplines, has been the fact that investigators started with an analysis of certain particular cognitive processes where certain single factors were quite predominant They then accepted this factor as the only important one in the case, and finally, because of the extreme continuity of the cognitive processes, they applied their generalization to all reasoning. When we have a formula which interprets all units of thought in terms, if not of all, at least of many of the most important factors, the danger of one-sided interpretation is excluded.

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[1] The word "Mneme" was coined by R. Semon He considered it as a very broad principle including all the various phenomena of organic reproduction, as distinguished from all other kinds of repetition "Memory, habit and heredity are partial manifestations of this 'mnemic' principle" In the present discussion, dealing only with phenomena within individual experience, the factor of heredity is entirely excluded from the concept of "mneme," and it is understood as a combination of memory in a broad sense and habit in a broad sense also, or, more definitely, as a capacity for acquiring enduring after-effects of experiencing and for reproduction (with modifications) of previous experiences and behaviour See Richard Semon, *The Mneme*, London, 1921, especially pp 11, 24

But from the point of view of this discussion the main value of the formula lies in the fact that it expresses so well the continuity of the thought process in all cognitive experience. If we can express by one formula all varieties of cognitive experience only by means of ascribing different quantitative values to the symbols of the formula, then the continuity of the process becomes much more obvious This rather abstract statement will be much more convincing if followed by a concrete illustration. For instance, if $Ni + Nd > P$,[1] we have a predominance of "stimulus" over "response," or cognitive experience which we call objective, if $Ni + Nd$ is considerably smaller than P, it will express the so-called "subjective" experience. If $Pn + Nd > Po + Ni$, then the inductive tendency outweighs the deductive one, and we have "induction"; if $Pn + Nd < Po + Ni$, we have deduction If R is great we have "intuition," or apprehension; if R is quite small we have reflective thinking If R is extremely great, or, in terms of the equation, if $R = \infty$, fusion of the old and new experiences takes place instantly without doubts and difficulties, in which case we have no conscious thinking at all. If C is small we have a fairly simple cognitive operation, like the apperception of something easily apprehended or solving a problem which involves just a few, definite data and factors. A large C would indicate a process of orientation in some very complicated and intricate situation. If we assume for each symbol, as its highest possible quantitative value, 10, and, as its other limit, 0, then the general formula can be used for the quantitative expression and evaluation of different particular cases of reasoning

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[1] $P = Po + Pn$.

As an illustration, let us take the creation of the Benzene theory as it took place in Kekulé's mind. Fortunately Kekulé has left an intimate record of this experience of his: "During my stay in Ghent, Belgium, I occupied pleasant bachelor quarters in the main street. My study, however, was in narrow alleyway and had during the day time no light. For a chemist who spends the hours of daylight in the laboratory this was no disadvantage. I was sitting there, engaged in writing my textbook, but it wasn't going very well, my mind was on other things. I turned my chair toward the fireplace, and sank into a doze. Again the atoms were flitting before my eyes Smaller groups now kept modestly in the background My mind's eye, sharpened by repeated visions of a similar sort, now distinguished larger structures of varying forms Long rows frequently close together, all, in movement, winding and turning like serpents! And see! what was that? One of the serpents seized its own tail and the form whirled mockingly before my eyes I came awake like a flash of lightning. This time also I spent the remainder of the night working out the consequences of the hypothesis. If we learn to dream, gentlemen, then we shall perhaps find truth—

"'To him who forgoes thought,
Truth seems to come unsought,
He gets it without labor'"[1]

In this case the rate of the fusion of previous and present experiences was very high, "like a flash of lightning" and therefore R may be given the value 9. Obviously this unit of reasoning was based mainly on a certain amount of previous experiences related to the problem, and only a small part of them was satisfactorily organized round the problem in question, since practically nothing was known of the structure of benzene molecules. This makes $Po = 2$ and $Pn = 8$. Present cognitive experiencing was very low and inactive, and we can hardly see any entirely new elements in it; this can be expressed by $Ni = 1$ and $Nd = 0{\cdot}1$. Finally, the degree of complexity of the problem was considerable, making $C = 7$, and the formula for the situation as a whole presents itself as follows:

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[1] *Berichte der deutschen chemischen Gesellschaft*, 1890, pp 1305–1307, quoted from Dr W Libby, "The Scientific Imagination," *The Scientific Monthly*, vol xv (1922), p 169

$$A = \frac{1}{9}[(2+8)+(1+0{\cdot}1)]^7.$$

The second case of the complete acts of thought presented by Dewey in his *How We Think* may be taken as another illustration "Projecting nearly horizontally from the upper deck of the ferry-boat in which I daily cross the river is a long white pole bearing a gilded ball at its top" This is a situation producing doubts and setting forth the problem: "What is the purpose of the pole?" After carefully observing the pole and boat, and taking into consideration everything that was known to him about the operation of the boat, the person who started to think about the problem, after rejecting a few other hypotheses as unsatisfactory, reached the conclusion "that the pole was set up for the purpose of showing the pilot the direction in which the boat pointed, to enable him to steer correctly."[1] In this case the fusion of previous and present experiences was much slower than in the first example, and may be described as $R = 5$. Previous experiences related to the situation were considerable—the gentleman daily crossed the river on this ferry-boat—but *only* a *small* part of the experiences, if any, was unsatisfactorily organized, since no puzzling elements in them are mentioned. So we may consider that $Po = 5$ and $Pn = 0{\cdot}1$ Present cognitive experiencing here is quite considerable, investigation of the situation, forming hypotheses and dropping them make $N_i = 7$. But Nd can hardly be considered greater than 1, since not much entirely novel experience can be seen in the whole situation. Since the complexity of this situation is not great, $C = 3$. The formula as a whole will be:

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[1] Op. cit., pp 69–70

$$A = \frac{1}{5}[(5 + 0\cdot 1) + (7 + 1)]^3.$$

A glance at each of the formulæ will at once suggest that the first case is an "intuitive" and complicated induction, while the second is a reflective solution of a relatively simple problem by application of previously known generalizations, in other words, a relatively slow and simple deduction.

It is obvious that the evaluation of the units of thought is very subjective and arbitrary, but it is no more, and perhaps less, arbitrary than common verbal descriptions of different examples of reasoning; besides, subjectivity in the case of the formula is mostly due to the fact that an evaluation has been made by only one person. If it represented an average of the evaluations of a large number of persons, its objectivity, as well as its reliability, would be much greater.

After this brief review of the different aspects of thought processes, it is now possible to formulate more definitely the canons of the new thinking and of dynamic Logic.

A more detailed inquiry into the mechanism of reasoning would be of great help for this purpose. We know that the essence of thinking is a union, a fusion of a new cognitive experience with previous cognitive experiences. It is also quite obvious that a new experience coming into our mind does not make the same connexions with all previous experiences, nor does it become uniformly distributed among all parts and sections of the bulk of previous experience as a whole, as a drop of tea, for example, would diffuse equally through all the water in a cup. In fact, any new experience enters not into a homogeneous mass of experience generally, but into a highly organized, very complicated structural system of different relationships It also establishes different connexions with different components of the whole of one's experience All this is quite obvious and can hardly be disputed, but when we try to construct a clearer and more detailed mental picture of how the union of new and old experiences really occurs, then everything at once becomes quite indefinite and uncertain Most students of thought processes would probably agree that the new experience establishes certain relationships primarily with types already existing in one's mind or, in higher forms of cognitive experience, with concepts, or ideas If we graphically picture the mind as a large sphere with types or centres of crystallization of experience scattered all through the sphere like small balls, then we may think of a new experience entering the mind like a little corpuscle coming into the sphere and moving towards the type with which it is going to be connected But what will take place when the corpuscle reaches its type? Will it coincide completely with its type, become, as it were, quite congruent with it? Or will they coincide only partially, and will certain features of the new experience stay, as it were, outside the type?

Obviously, they cannot become congruent, because that would mean that they are identical, and that there are types for all possible experiences In other words, it would deprive the centres of crystallization of the very essence of type. But if this is so, what position towards the type would the extra-typical features of the experience take? And, since different particular experiences possess different extra-typical elements, what would be the relationship of these elements towards each other and towards the type? And how under these conditions can the type itself change and grow? Then we take for granted that the new experience directs itself at once to its type, but actually it can hardly be so, at least in cases of definitely reflective thinking.

Let us see what answers can be offered to all these questions. The beginning of thinking is difficulty, confusion, and doubt,[1] "which is an expression of the fluctuation that results from viewing a statement from different points of view."[2] Often a long time passes before the terminating point, belief, is reached, because, again in Pillsbury's words, "there is no real acceptance of any fact until it has found a resting-place in some concept or law in the framework of our knowledge."[3] All this shows that the new experience, when entering, is attracted not by one centre of crystallization but by at least two competing influences The problems of the behaviour of a new experience under the action of two influences will be the next fundamental problem in the inquiry into the mechanism of reasoning. Generally speaking, methodologically it is, indeed, the most fundamental problem, because, even in cases where the problem is to find the result of the action of many influences, the most convenient procedure is to find first the resultant of any two of them, then the resultant of the second resultant, and of the next given influence, and so on, until all given influences are summed up. This method is used, for instance, in mechanics, when finding the resultant of several given forces. It would be quite helpful in our case also, if in reasoning new experiences were influenced simultaneously by three or more types. But there are many reasons for thinking that in this case the situation is simpler, that is, that in reasoning at any given moment only one comparison, one choice between only two possibilities takes place If it sometimes seems that in other cases reasoning goes on in a more complex fashion, it is only an illusion due to the very great speed with which many different but single comparisons follow each other. Says Pillsbury, "We are never conscious at the same moment of all of the characteristics of an object In fact, only one quality is ordinarily prominent in perception or thought at any one time."[1] Thus the case of the two centres of crystallization influencing a new experience stands as the basic problem in the study of reasoning. This agrees with Dewey's description of the origin of thinking: "Thinking begins in what may fairly enough be called a forked road situation, a situation which is ambiguous, which presents a dilemma, which proposes alternatives."[2]

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[1] Cf Dewey, *How We Think*, pp 9–13

[2] Pillsbury, *op. cit.*, p 37

[3] *Op cit.*, p 229

Certain other considerations about reasoning emphasize also the importance of two directing forces in the process of the entering of new experiences into our mind, and even give a certain suggestion of the nature of the two forces. This is the very well-known fact that all our cognitive experiences are based on contrast. Without darkness, we should not be able to understand what light is. If there were no such thing in existence as slavery, or imposition, or necessity, then the idea of freedom would have no meaning, would not exist. If milk were the only drink in existence, we should not have the word "milk," but should call it just "drink." If there were nothing to contrast with books, if there were no non-books, we should have no idea of the existence of books. Pythagoras's explanation of why we do not hear the alleged harmony of the spheres was quite sound logically and psychologically; just because there would be no single moment in our existence when we do not hear them, just because of the lack of contrast, we could never realize the fact that we heard them, even if they actually existed. Generally speaking, nothing can become an object of our cognitive experience if not contrasted with its opposite. Thus we can formulate the first principle determining reasoning in the following way: *No concept, no judgment, no unit of thought has any meaning or logical value without its opposite*, or, in other words, *No units of thought exist and function otherwise than in pairs of opposites.* This principle, if taken in the spirit of static Logic as something absolute and determined once and for ever, has no normative value but a descriptive one only. But if taken as something flexible, relative, admitting continuity from a very definite opposition between the opposites to a very vague and loose contrast, and therefore admitting quantitative modification, the principle possesses a very valuable normative counterpart, which may be accepted as the first principle of dynamic Logic.

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[1] *Op. cit.*, p. 95.

[2] *How We Think*, p. 11.

PRINCIPLE OF POLARITY : "EVERY UNIT OF THOUGHT IN RIGOROUS AND EFFICIENT THINKING MUST ALWAYS HAVE ITS DEFINITE AND EXPLICITLY EXPRESSED OPPOSITE AN A MUST NEVER BE USED SEPARATELY FROM ITS NON-A."

In the light of this principle we can see that a new experience entering one's mind is not attracted by any single type, but is affected by a pair of opposites and finds its place in one's experience as a whole guided by both poles of the pair

The next matter to be considered more in detail is the fact that concepts are not something uniform all through their structure They have none of the nature of a monolith, but on the contrary are more like a bunch of different connexions united only by a common centre like a set of many household keys on the same ring. And as we use only one key at a time, so only one certain aspect of a concept functions in any judgment, not the concept as a whole In terms of chemical language, concepts, types, are analogous not to the primordial units, electrons, nor even to atoms, but to molecules, and, as in any chemical reaction, molecules disassociate themselves into atoms or groups of atoms, so in any cognitive reaction, concepts participate not as a whole, but sometimes in one aspect, sometimes in another.

Most of the modern criticism of formal Logic, often a very successful criticism, centres around the negation of the possibility of understanding any concept outside of its context.[1] That cry "back to context" and "down with dictionary definitions " is only a partial realization of the fact that a concept never functions as a whole, but to say that a concept or judgment cannot be understood outside of its context, without specifying how the context may influence the concept, practically means nothing but a complete negation of any logical generalization about reasoning. In other words, it implies the negation of any Logic and the introduction of a rather new mysterious factor, "context," which does not explain anything and does not bring anything creative. But how does context really influence concepts? What is the selective factor which determines which aspect of a concept would function in any given context? The selective factor is the other concept, to which the one in question is opposed and with which it is contrasted A few illustrations will make this rather abstract statement more vivid and understandable Take, for instance, such a concept as " education " If one starts to think of it generally, that is, without any concrete problem before him, without any definite situation to be controlled in one or another way, then probably certain general ideas of education will come, something parallel to a dictionary definition which tries to embrace the meaning of education as a whole; but if the concept of education is used in definite rigorous thinking as a tool for reasoning in connexion with a certain problem, then always only one aspect of the concept will function Let us take as illustration the following statements:

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[1] Cf. A Sidgwick, *The Use of Words in Reasoning*, London, 1901, F G. S. Schiller, *Formal Logic*, London, 1912.

(1) " In spite of the fact that his musical education was very poor, he grew into a great composer." (2) " Although he was a good lawyer and an excellent baseball player, hardly anybody would call him an educated person " (3) " After years of studying the history of education, he became quite pessimistic and began to think that only some profound social and economic change, probably only a catastrophe, would bring mankind any chance for real progress and happiness " (4) " He sacrificed everything for his education, spent all his youth

in studying and reading, and only too late realized that the best part of his life was over and he had never even noticed the opportunities it had offered." (5) "Watching that amazing animosity between the educated few and the ignorant masses, he came to a paradoxical conclusion that, because education, in its higher form, will always be attainable only for the small highest section of the intelligence distribution curve, education is and will be an undemocratic and even generally immoral and anti-social force" A little reflection on the five statements will show that in each of them the concept of education, though generally identical, functions in its different aspects; and which aspect is put into operation is determined by the concept taken as an opposite to the concept of education The easiest way to see it is to try to imagine what kind of general discussion about education might be started by each of these statements The topics of the discussions would obviously be the following

(1) Education v natural endowment.
(2) Education v training.
(3) Education v. social revolutions.
(4) Education v life
(5) Education v democracy.

Each different opposite puts into operation its own particular aspect of the concept of education

Any other concept may be as good an illustration as that of education Freedom versus slavery, freedom versus necessity, freedom versus imposition; freedom versus licence. Knife versus fork, knife versus revolver, knife versus saw, knife versus hand (unarmed), knife versus wood (cut with it), and the like In all cases the opposite concept determines which particular meaning of the concept is wanted. By a diagram the relationship of the concepts can be expressed, as shown by Fig. I (p. 122)

In the above examples the concepts were taken in their deductive capacities, that is, as "types," or centres of crystallization in the experience as a whole. In their

Figure I

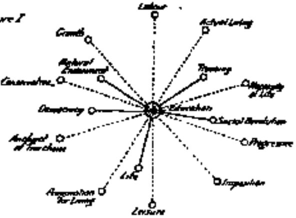


Figure II
(a)

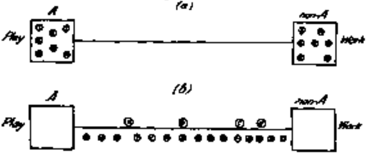
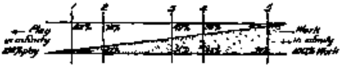


Figure III



inductive capacity, when they act as specific items presented to be incorporated into the general framework of our experience, they also function only partially and by a certain aspect, not as wholes. To take as an illustration the same concept of education, it is very easy to see that in no case are we capable of thinking of education in such a way as to take into consideration and pay attention to all aspects of the concept at the same time. Trying to find out the nature of education, studying what it is, after all, we always in any given moment are considering only one certain aspect of it Sometimes we think of education as growth, sometimes as a social problem, or as preparation for life, or instruction, or building up good habits, or as development, or as something that must be financed in one way or another, and so on, and so on In every case the aspect of the concept which functions predominantly is determined by a pair of opposites, but here, because the concept functions in its inductive capacity, the pair of opposites is outside of it. And this is what makes the difference between the inductive and deductive aspects of reasoning In the case of induction, the concept is not one of opposite poles in question, as in the case of deduction, but is itself a subject of influence of a pair of contrasting concepts outside of it The best illustration would be the discussion of education in Dewey's *Democracy and Education*. A bare list of the titles of the first few chapters, with a very few comments based on their content, will show how different aspects of education are expressed in terms of pairs of opposites—I. Education as a necessity of life (versus an object of free choice); II. Education as a social function (versus "a task directed by personal interest"), III. Education as direction (versus activities "dispersing aimlessly"), IV. Education as growth (versus outside imposition); V. Preparation (versus living), unfolding (versus continuous growing), formal discipline (versus "the broad and consecutive interaction of specific activities with one another"), VI. Education as conservative (versus progressive); VII. The democratic conception of education (versus aristocratic and individualistic); VIII. Aims in education ("A true aim" versus an aim which is imposed upon a process of action from without); IX. Natural development (versus social efficiency); X. Interest and (versus) discipline; XI. Experience and (versus) thinking (mere bodily action versus spiritual activity). XII. Thinking in education (thinking versus subject of thinking); XIII. and XIV. The nature of method and (versus) the nature of subject-matter; XV. Play and (versus) work in curriculum; XVI. and XVII The significance of Geography and History and Science in the course of study (information studies versus habit-forming studies, logical versus psychological, naturalism versus humanism); XVIII. Educational values (intrinsic versus instrumental). XIX. Labor and (versus) leisure, XX Intellectual and (versus) practical studies, XXI. Physical and (versus) social studies. The following chapters treat directly the more philosophical aspects of educational problems, but the method is everywhere the same In all these cases the concept in question—education—is not one of two opposite poles, as it was above in the case of the deductive function of the concept, but, being presented in its inductive capacity, it is itself a subject of the influence of the pairs of contrasting concepts outside of it The same thing would certainly take place in all similar places. Graphically this may be presented in diagrammatic form by Fig. I. (p 122). The circles are centres of crystallization of experience as a whole; the black lines connect the poles of pairs that determine which aspect of the concept "education" functions, when the concept acts as a "centre of crystallization," directing a new coming experience. The dotted lines connect the poles of pairs which determine the acting aspect of the concept when it comes in as a new experience.

To see the significance of the pairs we have to analyse the process of the organization of experience and of the accumulation of knowledge more in detail and in terms of the polaric system But first, the description of the functioning of concepts just presented must be more definitely formulated · THE PRINCIPLE OF THE PARTIAL FUNCTIONING OF CONCEPTS. "A COMPLEX CONCEPT IN ACTUAL REASONING AT A GIVEN MOMENT NEVER FUNCTIONS AS A WHOLE, BUT ONLY IN A CERTAIN ASPECT. WHICH ASPECT IS PUT INTO OPERATION IS DETERMINED BY A PAIR OF OPPOSING CONCEPTS. IN CASES WHERE A CONCEPT FUNCTIONS AS A COMPONENT OF THE PREVIOUS EXPERIENCE, IT IS ONE POLE OF THE PAIR. IN CASES WHERE A CONCEPT FUNCTIONS AS A PRESENT EXPERIENCE, BOTH POLES OF THE PAIR ARE EXTRANEOUS TO IT. IN EFFICIENT THINKING THESE PAIRS MUST BE EXPLICITLY EXPRESSED"

It has already been mentioned many times that thinking begins with difficulty, doubt, oscillation, alternative It involves choice between at least two possibilities, two concepts, and these two opposing concepts determine the direction of inquiry. Maybe next moment the direction of the investigation will be changed and the pair of opposites will also be correspondingly changed, but this would only mean that one pair is replaced by another. So the fact that the inquiry along a certain direction is determined by its two poles is the fundamental and primary element of reasoning Therefore, the best way to begin the study of the organization of experience and accumulation of knowledge would be to start with an analysis of this fundamental case. The following simple example will do. A young man starts to study water-colour painting of a special kind, namely, pictures painted on white paper with black colours of different degrees of intensity. What will be the development of his cognitive experience and accumulation of knowledge of colours in the paintings? From the beginning he will certainly know the two contrasting colours, white paper, black colour The very first glance at any of the paintings would suggest it. And quite probably in his first creative effort he would use only the definite black over the pure white. But all further progress in his study of the appreciation and use of colours will be the differentiation and production of different shades of grey between black and white. At first, probably, he would be able to distinguish only a few, let us say from 3 to 5, different shades of grey, but the more experience he gets the more different shades he will know, the more connecting links between black and white will be inserted. In other words, the growth of his knowledge in this field will be nothing but the growth of continuity between black and white. The closer the shades of grey approach perfection of mathematical continuity, the more perfect will be his knowledge. In his mind the transition from the blackest possible to the whitest possible will be so easy that it will be difficult for him to think that he cannot go in the black direction beyond the darkest shade he has experienced, or in the white direction beyond the whitest shade known, and therefore the black which is one hundred per cent black, as well as the one hundred per cent white, will both disappear from reality for him and will become just very extreme shades of grey. The opposition between black and white will disappear, and he will think of all his colour experiences as of something both white and black simultaneously. His experience of the colours will be highly organized, he will think of it in terms of the formula "A is B and non-B at the same time," and his knowledge of the subject will be excellent.

After this quite simple but typical illustration of judgment, which is the most representative form of reasoning, we may take a rather more complicated problem Let us take the experience of a specialist, a psychologist, studying play. First of all, he has to contrast "play" with something else, because if not differentiated from everything else, it would not exist for his mind, and it would be impossible even to think of it. Furthermore, in order to see his problem clearly and to formulate it in a practical, workable way, he has to contrast play not with everything "not play" in general, but with something specific and closely related to it Let us assume that he opposes play to work. This would at once determine the direction of his inquiry—he would study the play-work pair. At that stage his knowledge of the play-work phenomenon is very limited, and its growth will be conditioned by his experience of the play-work activities he observes. Here two possibilities are conceivable: if he would adhere to the letter and spirit of the old static Logic with its perfect one hundred per cent purism (which is hardly possible in reality), then he would classify all his experiences either as one hundred per cent play or one hundred per cent work. Graphically it can be represented by diagram II (p 122), where squares represent the concepts in question and circles with numbers the corresponding experiences in their chronological order. The concepts will stay separated all the time, and no more refined, more organized, and more detailed knowledge will result But if the person happened to be a keen observer and not indoctrinated with static Logic, then he would soon see that practically no single activity would be either one hundred per cent play or one hundred per cent work, but all of them would be a combination of both play and work, only in different proportion. Then he would not divide them roughly into two groups, but would distinguish them one from another, and distribute them to the play and work poles in accordance with the proportion of play and work in each (diagram II. (*b*)). The more of the play aspect any experience possess, the nearer it is to the play pole, the more of the work aspect, the nearer it is to the work pole

With the growth of his experience, the number of the transitional forms between the play pole and the work pole will grow also. In the case of a perfect knowledge of the problem, all possible cases would certainly be inserted between the poles, and the continuity between them would also be very near to perfect. We cannot expect to have such perfection actually, but graphically it can be illustrated by diagram in Fig. III, (p 122)

The play aspect is represented by white; the work aspect by a dotted space The black vertical lines between the poles represent different concrete experiences. It is easy to see that if a continuous scale like this is constructed, any play-work phenomenon can at once be quite precisely located in accordance with its proportion of play and work aspects. Such a perfect continuity and knowledge are certainly only imaginary or, so to speak, ideal. In all actual cases, we have only a more or less close approximation to it, but the general principles are the same, the more steps there are between the poles and the better the continuity is, the better are the knowledge and organization of experience So we see that the essence of dynamic reasoning is the establishment of continuity between previously separated pairs of opposites. How, and with what success, this principle can be applied to other problems, has been shown above in the analysis of Dewey's essay *Interest and Effort in Education*. Many more illustrations can be found in Dewey's other writings, especially in his *Democracy and Education*, which in its logic presents a continuous application of the principle of continuity.

It is easy to see that there are two stages in the application of the principle of continuity In most cases, as, for instance, in *Interest and Effort*, the continuity is usually only indicated and continua are accepted, as it were, only in potentiality. They are not realized, in the sense that some real series of transitional forms is introduced between the poles. But practically, the full value of the continuity principle may be seen only when the continua are actually constructed and the potential continuity is objectified. This leads us to the next principle of dynamic Logic. But before we come to it, the princip. of continuity must be stated and certain aspects of its application discussed.

THE PRINCIPLE OF CONTINUITY "THE ESSENCE OF DYNAMIC REASONING IS THE ESTABLISHMENT OF CON-

TINUITY BETWEEN TWO OPPOSITE POLES OF A UNIT OF THOUGHT WHICH TENDS TO TERMINATE IN A REALIZATION OF THEIR QUALITATIVE IDENTITY EFFICIENT THINKING MUST START WITH AN ASSUMPTION OF CONTINUITY IN POTENTIALITY, AND WORK FOR ITS ACTUAL REALIZATION."

For a clearer and more complete understanding of the above presented scheme of the organization of cognitive experience, some questions must be answered which naturally arise when thinking of the scheme What is the origin of the poles, or how do they come into being? Do they pass through any changes during the process of accumulation of experience? And if so, then how? What are the factors determining the point of location of any new experience on the scale of continuity?

The question of the origin of the organization of our experiences is very hard to answer The polar conception does not introduce any special difficulties, and probably even decreases them, but nevertheless it would be very difficult to answer the question definitely Beyond doubt, in the infantile mind the process of condensation of the primordial chaos of impressions and the shaping of the centres of crystallization of experience is very gradual and slow It is impossible to register the exact moment of the formation of certain concepts or pairs of opposites and to describe their structure at the particular moment. But, generally speaking, the beginning of the functioning of a pair of opposites may be traced to two experiences appreciably different along a certain line. When differentiated and contrasted, the two experiences start to function as poles of the potential continuity. Going back to the graphic interpretation, the two initial experiences, the initial poles, may correspond to any two different points on the well-developed scale of the continuity. They may be (diagram II. (*b*), p 122) *a* and *c*, or *c* and *d*, or *a* and *d*, just as it might occur by sheer chance. In so far as other experiences are not of a more extreme character than the initial two, they continue functioning like the poles. But if any more extreme experience comes, it assumes the function of the pole and the range between the poles in this way increases and increases until later the poles cease to exist as definite "typical" experiences and become only indicators of direction as, for instance, east and west, left and right, plus and minus, which do not designate any definite point but merely suggest direction.

Other changes through which the poles pass are not changes of position, or as it were, spatial changes, but changes in the regulating and guiding power of the poles. The term "power" does not here mean a manifestation of the energy with which physics and chemistry are concerned, and which may be expressed in terms of calories or joules. The introduction of the term is not an attempt to introduce physical laws into the study of reasoning, but only a search for a good, expressive, symbolic representation. Static Logic took its symbols and diagrams from a static discipline, geometry S, P, and R circles are familiar to every student of Logic Dynamic Logic, assuming reasoning as a continuous process, cannot find the appropriate symbols in geometry, and has to look for them in the science which studies motion—in physics, or, to be more precise, in dynamics, or, specifically, in kinetics It is helpful to think of an incoming experience as of a body under the influence of the forces of attraction exerted by the poles. Many factors determine the magnitude of the forces of attraction of each pole in any particular pair. To press our analogy further, we may think of the poles as centres of gravity (or, more precisely, centres of parallel forces) of the corresponding elements of all the previous experiences. If, in a certain pair, most of the experiences are of the outweighing "A" elements, then the pole "A" will be stronger than the pole "non-A" For instance, if a person has lived mostly among honest and decent people, for him, in the pair honest-dishonest persons, the "honest people" pole will exert the stronger power of attraction, and he will have a tendency to overrate the honesty of every one he meets, while another person who has dealt largely with crooks will overrate the wickedness of the people he meets.

The other factor determining the magnitude of the forces of attraction is the "affective tendencies" (Rignano) associated with the poles in question It makes no difference whether the affective tendency is positive or negative, its intensity only is what counts. A capitalism-hater sees capitalistic intrigue everywhere, and a socialism-hunter attacks it where it has never been present. A youth not quite successful in his courting interprets any smile of his lady-love as a sign of attention to him, and a loving mother tries to read any change as a sign of recovery in her sick child In addition to the two factors of direct personal experience, the experience and attitude of the social group to which an individual belongs play quite a considerable part in strengthening or weakening the particular poles of different pairs. For instance, for an average mediaeval mind, in the pair "natural and supernatural" the latter pole was much stronger than it is for the modern mind, and in the pair "mental work-physical work," the former pole will be stronger in a professor's family than in a labourer's.

But the relative strength of the poles is certainly not the only factor determining the location of the incoming experience between the two poles It depends chiefly on the nature of the experience. The more "A-elements" it possesses, the nearer it will be located to the "A-pole"; the more "non-A elements," the closer it will be to the "non-A pole." In the continuity "play and work," the game of hide-and-seek will be located fairly close to the play pole, and unloading a freight steamer nearer the work pole, while a base-ball practice of professional players falls somewhere in the middle. There is one danger in thinking of the reasoning processes in terms of the polar system, namely the danger of building a too simplified conception of cognitive experiences. Looking at the diagrams II (*b*) or III (p. 122), for instance, we always have to keep in mind that it is only one unit of thought, temporarily and artificially isolated for the purpose of understanding it better, and that it must never be thought of as a generally self-sufficient, separated entity The poles work and play, for instance, actually have a very large number of connexions with other different pairs of poles, for example, mental - physical, educative - uneducative, noisy - silent, cheap-expensive, refreshing-depressing, free choice-imposition, and the like The incoming experience on the diagram is represented by a point of no dimensions, but this is only one aspect of it. Simultaneously it may be a point on the line of continuity of very many other different pairs, such as active-passive, effort-interest, satisfaction-annoyance, destruction-creation, joy-sorrow, and so on

From this point of view diagram II (p 122) does not represent a real situation as it is in all its complexity, but for most practical purposes the simplification introduced is necessary and helpful The method used, as mentioned above, is exactly the same as in mechanics, when one tries to find the result of the influence of two certain forces, then of the resultant and some third force, then of the new resultant and the fourth force, and so on, until all the given forces are taken into account. At any given operation dealing only with a pair of forces the engineer never forgets the whole system of forces, the complete influence of which he will eventually express The same attitude and procedure must be aimed at in the polar interpretation of reasoning.

The next principle of dynamic Logic may be called the principle of *quantitative* indices. As was shown above, the continuous reorganization of cognitive experience within a certain limited field terminates in the construction of a continuous scale between two opposite poles. The more perfect the continuum actually is, the more excellent is the knowledge. In our illustration, the painter of the water-colour sketches reaches complete mastery in the use of colour only when he is able to differentiate all possible shades of grey and to locate them in a continuous scale of shades from black to white, which has been constructed in his mind as a summary of his whole experience along that line. Only then can he, without loss of efficiency, abandon the opposition of black and white and consider the shades of colour as different degrees of grey. But if he could not definitely see the quantitative differences between the various shades of grey, and yet dropped the opposition of black and white, assuming their continuity only in potentiality, then he would not be able to have any experience of black, white, or grey. Thus we see that the real means of his cognition, a real tool of reasoning and the standard of judgment, is the continuum actually constructed between opposite poles. The potential continuity, not realized in the form of a scale, indicates only the correct direction for further cognitive experiences, and is not sufficient for securing real knowledge helpful in controlling the environment.

In a certain way potential continuity, without any actually constructed scale (the situation is practically almost impossible), is even worse than static logic. Static logic provided at least for a crude (and actually false) differentiation—A and non-A, black and white—but potential continuity alone, assuming qualitative identity and not providing for quantitative differences, practically takes away all possibility of any differentiation, and consequently of any experience. Thus we see that the most important point in dynamic Logic, its very essence, is quantitative differentiation, quantitative indices. The expert in the above-mentioned " play and work " problem would at once cease to be an expert if he lost his ability to see the exact quantitative difference between different combinations of play and work. In order to be able to identify and estimate any play-work experience presented, in order to construct any desirable combination of the play and work elements, the expert must have in his mind something like a continuous series of all possible different examples of the play-work combination, something like a piano keyboard, so that, using proper keys as a standard, he can verify his judgment and be sure that he has identified or constructed the combination correctly But this measuring-scale in the mind, although helpful, and, indeed, practically indispensable, has a very important defect, it has very little social value, it is not communicable J. S. Mill's well-known story about the dyer illustrates this point excellently. A working dyer, famous for producing very fine colours, was offered a position in a factory, that he might teach other workmen the same skill. But the famous dyer's method of proportioning the ingredients, in which lay the secret of the effects produced, was by taking them up in handfuls, while the common method was to weigh them, and therefore his remarkable skill in finding the proportions exactly needed turned out to be so personal that he could impart his skill to nobody If members of a social group want to express themselves correctly and exactly, or if they want to co-operate in any constructive activity, they must find some common language. In the case of the water-colour artist mentioned above, the scale of colours in his mind worked excellently for all his purposes; but if one wants to get a paint of a certain definite shade or to explain to others what colour he has in mind, the best way will be to use a series of patterns of different paints supplied by any big concern, and then to indicate what is wanted in terms of the pattern. The same procedure must be applied to all our judgments, to all our reasoning. Our scales for all the most important pairs of opposites in any field of knowledge must be made objective and explicit and in such a form that the quantitative value of any step can be easily understood and communicated. In other words, all our units of thought, all our judgment, must always be measured, expressed by certain definite quantitative indices. Only then can we in full measure enjoy the great advantage of dynamic logic, its flexibility, without suffering from indefiniteness, vagueness, and meaninglessness, for, indeed, any statement without a quantitative index is meaningless from the point of view of the control of environment. Only when an experience is defined in terms both of the poles determining the direction of continuity in question and of its relative position on the scale, that is, by means of a quantitative index expressing the ratio of the opposite elements in it, only then has experience a definite, working, and efficient meaning

In order really to mean something, any meaning must show this indispensable quantitative evaluation, so much so, that both static Logic and the reasoning of our every-day life are obliged to introduce it, although in rather an inefficient and unorganized form In accordance with its fundamental law, "A is either B or non-B," static Logic assumes that any new individual experience may either completely fit a certain type, a concept, or be entirely outside of it. *Tertium non datur*—consequently, no quantitative discrimination is given in connotation (in intension), it is to be sought only in denotation (in extension) If any single experience may be either made the type or outside it, the only quantitative problem that can be considered is to find out how many single experiences within a certain group are in the type and how many outside it. Static Logic provides three possible answers to the question · all, no, and some. All men are mortal; no men are apes, some people are rich The first two groups, all and no, being absolute dogmatic statements, have hardly any practical value in our ever-changing universe of experience, except in the case of very definite truisms But even here, if taken absolutely one hundred per cent, they would make even truisms untrue Strictly speaking, and endeavouring to be precise, it is much safer to attribute to all statements the form "some" But the formula is quantitative in its intent only, and not in its achievement. If the percentage is not given, the formula does not say anything; it is good for all cases from 99·999.... per cent to ·000.....1 per cent; or, in other words, quantitatively it may mean anything, and therefore means nothing. But, even if the percentage itself is given, only a very small part of the needed quantitative data will be available. For most practical purposes it is necessary to know, not only the percentage of the members of the group possessing certain qualifications, but a certain indication as to which members of the group they are. For the police it is not important to know that some persons in the city are criminals. It wants to know what percentage of the whole population is criminal and, what is more important, who the criminals are. In other words, it brings us back to the problem of the quantitative evaluation of the single experience, which has been completely neglected by static Logic. To sum up, static Logic has entirely missed the problem of quantitative evaluation in connotation, and in denotation it has attempted to solve the problem in such a verbal, inefficient way that actually what has been achieved possesses hardly any practical value

The thinking of everyday life has faced the problem more straightforwardly In our conversation the quantitative value of judgment, both in connotation and in denotation, is usually expressed either directly or indirectly Sometimes the quantitative value of our statements is determined by certain modifying words and expressions like "few," "many," "most," "much," "quite," "very," "considerably," "one hundred per cent," and so on, but in most cases this is probably done by what is usually called the context (that rather mysterious factor) By the context is meant, not only the different combinations of words used, but all our behaviour accompanying our statements—intonation, facial expression, pitch of voice, general posture, and the like

There are hundreds of different ways in which the words "I am awfully sorry" can be pronounced, so as to express nearly all degrees of apologizing from merely formal and insolent excuse to the deepest and most sincere regret. The statement "I have a cold" has entirely a different quantitative meaning when just dropped in the middle of a quiet talk, as when announced by telephone, or when cabled from Europe. But all such discriminations, though often very fine and minute, are very subjective, very hard to compare with one another, unsystematic, or, in other words, amateurish and unscientific. The reliable, practical, and efficient quantitative evaluation can best be expressed by means of objective, continuous scales constructed for the pairs of opposites in question.

Besides their social value, due to the communicability emphasized above, the objective scales are also very helpful in individual thinking. One of the most fundamental facts about reasoning is that, especially in its higher and more complicated forms, it cannot function successfully without fixing its types or concepts in some tangible form; in other words, without the use of symbols. The whole history of human thought, and especially the growth of the mathematical sciences, proves this beyond a doubt. The more elaborate the system of symbols is, the better are the conditions for the advancement of reasoning. Even in the case of quite a simple kind of judgment, as, for instance, the judgment of shades of colours, symbols are definitely necessary. Lehmann showed in his experiments that people can readily discriminate only as many shades of grey as they have names for. If a person is given more names, he can distinguish more shades of colour than before.[1] If such rather primitive symbols are so helpful in both simple and complicated cases of judgment, the exact, very systematic, tangible, and quantitative symbolism of the scales of continuity will be of even greater help.

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[1] Lehmann, *Ueber das Wiedererkennen* (*Phil. Studien*, vii, 469), quoted from Pillsbury (*The Psychology of Reasoning*), who writes of the experiments: "As many different shades could be recognized on representation as there were words in the vocabulary of the subject" (p. 73).

There is another possible advantage in having scales of continuity which deserves notice. All our judgments, as mentioned above, are influenced to a considerable degree by the nature of the newly presented experience and of previous experiences, and also by the affective tendency towards one or the other pole. The affective tendencies, or in other words, the emotional attitudes, personal interests, individual tastes, selfish egotism, particular sympathies, and so on, are the most favoured and most popular explanation of the fact, that so often, in our discussions, we cannot reach any definite statements or decisions acceptable to all concerned Lord Bacon speaks of them under the name of "idols of the tribe and of the den" Locke mentions "passions" as one of the causes of wrong beliefs The old static Logic even enjoyed considerable benefit from these emotional, extra-logical influences, claiming that they were a kind of *force majeure*, the pressure of which Logic could not withstand.

As a matter of fact, it is only partially true. The affective tendencies do tend to divert our thoughts from correct judgment, but they succeed only in proportion to the weakness of Logic. To consider "passions" as a force insuperable to Logic is always a *testimonium paupertatis*. To be more specific, it is a confession of general vagueness of reasoning and of lack of preciseness in qualitative and especially quantitative discrimination and judgment It is easy to call something we do not like "bunk," or somebody we hate a "scoundrel," but to specify what is really meant by these terms and tell why this is "bunk," or that man a "scoundrel," is not so easy. Even a person who has the strongest possible aversion to admitting the instability of his financial status will realize it if he definitely sees in his pocket-book only ten or fifteen cents. An angry man will readily consider somebody who is the cause of his trouble an idiot, and a loving mother probably enjoys thinking of her boy as a genius, but when confronted with I Q 's, computed by experts and revealing the contrary, both the angry man and the loving mother would be forced to modify their judgments. The less precise thinking is, the more chances there are for the misleading influences of the affective tendencies It is easy to see that dynamic Logic, which introduces more precision into qualitative discrimination by means of pairs of opposites and more exactness in quantitative evaluation by means of quantitative scales, will considerably decrease the power of the "passions" and personal idiosyncrasies

This discussion of quantitative evaluation may be summed up in the form of the fourth principle of dynamic Logic.

THE PRINCIPLE OF QUANTITATIVE INDICES · "NO STATEMENT HAS ANY DEFINITE MEANING WITHOUT A CERTAIN QUANTITATIVE INDEX IN EFFICIENT REASONING, THE QUANTITATIVE VALUE OF ANY UNIT OF THOUGHT MUST BE EXPLICITLY INDICATED, PREFERABLY IN TERMS OF OBJECTIVE CONTINUOUS SCALES BETWEEN THE TWO POLES OF THE OPPOSITES"

In the above presentation, the four fundamental principles of dynamic Logic were approached from the psychological point of view, but logically they are only the outgrowth or, better, a more elaborated form of the most essential, basic, and comprehensive law of thought, " A is both B and non-B simultaneously" If one accepts this and starts to think consistently on the basis of this, the next question at once naturally arises "If this is so, how much of B and of non-B does A possess ? " And then, almost automatically, the other implications expressed in the four principles given above emerge and construct the whole system of dynamic Logic

In conclusion, the following warning must be sounded. In the discussions of dynamic Logic, care must be taken not to make the mistake of accepting first the postulate " A is B and non-B," and then later discussing its corollaries and deductions in terms of static Logic. Utter confusion and increasing misunderstanding would follow the mistake. It must always be kept in mind that the postulate "A is both B and non-B" is indeed the most primary, the most essential, and the most comprehensive in this system of reasoning, so that no other proposition is before it or above it. Once accepted, it must be the criterion for all other judgments, not the subject of a test by any other principle.

CHAPTER VI

APPLICATION OF DYNAMIC LOGIC

All theory, dear friend, is grey,
And green, alone, life's golden tree.—GOETHE.

As has been shown in the previous chapters, the new dynamic Logic, based on the law "A is B and non-B at the same time," possesses many advantages over the old static Logic, built on the principle "A is either B or non-B," where *tertium non datur*. It deals more efficiently with problems which have been unsolvable puzzles to static Logic "Sophisms," when interpreted in the light of dynamic Logic, turn out to be, not enigmatic curiosities, but very significant and representative exemplifications of thought processes interpreting the changing Universe but bound by the canons of static Logic. It fits the general spirit and trend of scientific reasoning more adequately. The tendency towards continuity, dynamism, and quantitative differentiation, typical of modern science, can obviously find better means for self-expression in dynamic than in static Logic The canons of dynamic Logic are more in harmony with the best examples of current reasoning. Dewey's ways of thinking and of attacking problems from the logical point of view are in essence the first three principles of dynamic Logic, consistently and systematically put into practice Dynamic Logic is backed and supported by modern psychology. Everything that we now know about processes of thought leads to dynamic Logic and away from static Logic. But it is hardly possible for all these general considerations or circumstantial evidence, as it were, in favour of dynamic Logic, though probably in themselves quite interesting, fully to justify its coming into being and to prove its importance unless its practical value is directly demonstrated. Logic, generally, is a branch of engineering, and therefore the real crucial test of dynamic Logic must be its usefulness and efficiency. If it can bring with it a better control of our environment, if it can make our decisions more conclusive and our arguments more convincing, then, and then only, dynamic Logic can prove to be something of real value and importance.

Like any normative science, Logic may be helpful in two ways: for the discovery and elimination of mistakes in thinking already going on, and for the construction of certain devices and designs for more correct thinking in the future. The latter constructive and preventive method, if sufficiently developed, is in the long run much more effective. Yet the former destructive and curative approach is also quite useful, especially when the science in question is young. Since dynamic Logic is, as a practical discipline, quite young, it is more convenient to start with the curative method.

As has been mentioned above, the shortcomings and defects of modern thinking are due chiefly to the fact that, being dynamic in spirit, it has to express itself in terms of the old static Logic. Now, after a more systematic presentation of the canons of dynamic Logic, this fact may be expressed more definitely and precisely. The defects of modern reasoning are due chiefly to neglect or violation of one or several of the four principles of dynamic Logic. Before going into a detailed discussion of this statement, it may be helpful to remember that the violation of the principles of dynamic Logic must also be thought of in the spirit and by the method of continuity. All the four principles are so intrinsically interconnected and interrelated that it is impossible to show a definite demarcation-line between the violation of one of them and the neglect of others. Practically every case is a violation of all of them, but in a different degree. On the other hand, it is almost impossible to find a case of complete violation of any of them. The principles are quite indispensable to any intelligent thinking, or rather, to any thinking whatsoever, and therefore they cannot be completely neglected without destroying the last shadow of meaning of a statement. As far as any statement has any meaning whatsoever, it must conform to these principles either explicitly, or by assumption, or in some other form. Thus, when the violation of a certain principle is mentioned, it means the violation of this principle to a degree considerably greater than of the others, but by no means one hundred per cent complete.

Strictly speaking, there is only one real and convincing test of the usefulness and efficiency of any general principle, namely, to put it into operation, to apply it to an actual problem in an actual environment and to see whether it works or not. In a printed discussion this kind of test in a pure form is hardly possible The closest approximation to it would be to take some typical example of reasoning as an illustration, and to see how dynamic Logic would work there.

For the sake of convenience, let us take the four principles of dynamic Logic, one after another, and see what the violation of each of them would bring

The first principle is *Every unit of thought in vigorous and efficient thinking must always have its definite and explicitly expressed opposite An A must never be used separately from its non-A*

The neglect of this principle, if complete, would result in complete meaninglessness It cannot actually happen, because it is always possible to find a contrasting concept to any notion merely by adding a " non " to it, even if no real contrast can be found in first-hand experience. But the contrasting notion produced in so barely formal and verbal a way would have only a formal, verbal meaning, that is, it would have no pragmatic significance, and would be meaningless from the point of view of controlling the environment.

A good illustration of this is an experience through which nearly everybody passes between the ages of twelve and sixteen, that is, the discovery that all instances of human behaviour, even the noblest deeds and greatest sacrifices, are merely egoistical because they bring an intense satisfaction to the people who perform them. The realization of this fact, that there is no such a thing as altruism, usually brings a severe shock to the young mind, but under normal conditions the depression does not last long. Usually it does not take a long time for a youth to understand that the removal of altruism as a contrast to egoism equally affects the notion of egoism, depriving it of any real and significant meaning. If every human action is egoistic, if both starving a child to death to save money for drink, and volunteering to jump into the ocean from a crowded boat to save others, are merely "egoistic," then obviously the notion of egoism does not help us to understand life. It is a very poor tool for reasoning about, discussing, and organizing the world about us, and must either be thrown away or improved. And it can be improved only by introducing notions of higher and lower forms of egoism or, probably, of social and antisocial, desirable and undesirable egoisms. It makes no difference, which pair introduces the two contrasting concepts; they will merely be other words for the same classification, for the same mental process, as was expressed in the pair altruism-egoism.

Exactly the same thing happens when the term social is used in too wide a sense—as sometimes takes place as a reaction against the one-sided individualistic tendencies of the past. If all human activities are social, if the life of a hermit somewhere in a desert, completely disassociated from the sinful world, is social as well as the career of a leader of a political party, if the "individual" is a discredited hypothesis, if there is no such a thing as personal or individual, then the term social loses its meaning unless modified and restored to usefulness by indicating its opposite in some other words.

The following discussion, rather typical and not unusual among students of education, gives another illustration of the same fallacy. When the statement is made that the best and most modern method of education is guiding children by a proper arrangement of their environment, someone not quite agreeing with the maxim often asks: "But don't you think that sometimes good books also influence children in a very desirable way?" "Yes, certainly," is the answer, "but are they not also part of a well-arranged environment?" "Then, I think, the personality of teachers, their general attitudes, ideals, and aspirations, their personal magnetism, as it were, are of great importance in education. Don't you think so?" "Oh yes, a teacher is certainly an important factor in the educative process, but she again is only a part of the environment of the child. Is she not?" By these answers the truth of the statement is saved, but its meaning is lost or reduced to the most insignificant platitude, for if environment is anything and everything that influences a child, then all educators of all times have always used the same method of "the proper arrangement of environment," just because it was and is the only possible one. The same train of reasoning leads to the same result in the case of the proposition that observing and knowing other people's behaviour is the best way to know their character. This proposition is often reduced to a formal and verbal statement only by the admission that behaviour means everything observable and knowable in people.

Another good illustration of a rather meaningless statement is the educational motto, "Education is Life," nowadays so popular. For many people who see much behind the words, for those to whom the statement is a symbol of something very significant and enlightening, it would probably be hard to realize that the motto "Education is Life," taken as a statement at its face value, is practically meaningless, but nevertheless it is so. What can the statement mean as it stands? Certainly not that education is identical with life in the sense used in Natural Science, for then educational researches would be identical with biological work. Nor can it be identical with the life with which Social Science, deals, for that science considers such aspects of life as adultery, cruelty to children, belligerent intolerance, parasitism, and so on, which can hardly be considered educational by anybody. It is possible to consider the motto as a declaration, first, that education does exist; and, secondly, that it deals with living beings. But, again, hardly anybody who backs the statement would accept such an interpretation as the real meaning of the statement. Yet the statement actually does not express anything more. If this is so, how can its popularity be explained? The explanation lies in the fact that although the statement has hardly any meaning in its present form, yet it may have very many meanings if slightly modified, namely, if there were some indication of the concept to which the notion of "life" is taken to be a contrast And because everybody thinks of the statement as always modified in this way; in other words, as contrasted with something opposite to it, it has for him subjectively a fairly significant meaning Life being a very broad and many-sided concept, there is an almost indefinite number of possible modifications, and consequently of different possible meanings, and therefore, being actually, structurally, so to speak, meaningless, the statement in operation, thanks to those subjective modifications, takes on very many different possible meanings or, in other words, becomes ambiguous. This leads us to the second principle of dynamic Logic.

The second principle is the principle of the partial functioning of concepts. *A complex concept in actual reasoning at a given moment never functions as a whole, but only in a certain aspect. Which aspect is put into operation is determined by a pair of opposing concepts In cases where a concept functions as a component of the previous experience, it is one pole of the pair In cases where a concept functions as a present experience, both poles of the pair are* *extraneous to it. In efficient thinking these pairs must be explicitly expressed.*

If neglect of the first principle results in meaninglessness, neglect of the second principle brings ambiguity. A typical example of ambiguity due to neglect to indicate the contrasting concept may be found, for instance, in the current use of the word " natural." It is one of the most loosely used words. It can be contrasted with supernatural, and mean " in accordance with the laws of nature," or with extraordinary, and mean " usual, common," or with queer, fanciful, and mean " simple, sound," or with artificial, perverse, and mean " normal, correct, right, proper, good." We could easily imagine for ourselves what confusion, misunderstanding, and false conclusions can result from the unmodified use of the word, even if reality had not already supplied us with good illustrations in the form of the ingenious methods of defence so often used by criminal lawyers for the benefit of their clients. The first step is usually the presentation of the case with explicit or implicit emphasis on the fact that everything in the crime itself and anything connected with it happened naturally—in complete agreement with the laws of nature. The proposition looks and actually is quite convincing, and paves the way to a gradual shift to another aspect of the concept " natural," and to convincing the jury that the crime was also something " natural," in the sense of " not far from usual." Then follows a slide to the " normal " aspect of " natural " and the behaviour of the criminal already begins to look not quite so bad, but when the notion of " natural " is pushed a little farther—to " natural " meaning " proper," the criminal looks even more like a good, normal, and respectable citizen. As a finishing touch, just a little more pedalling on the " natural, correct, right " connotation, and the criminal is saved from punishment. The transfiguration of the evaluation of the deed from " not miraculous " to " proper " proceeds smoothly and readily because everything in the process moves the whole time round the same concept "natural" as a uniting centre.

Very often the logic of temptation takes the same path. The tempting act, that is, let us say, some sexual excess, is looked at first as natural, that is, "in accordance with the laws of nature," not supernatural, which is perfectly true, it is then shifted to natural, meaning common, which is probably not so true; and finally to natural, meaning normal and proper, which is probably quite wrong.

The current use of any broad and popular modern idea, such as, for instance, democracy, socialism, anarchism, would also supply many expressive illustrations Democracy is probably the best example It would certainly require special and extensive research to investigate the different meanings of the idea as actually used This research would reveal some very interesting facts of typical aspects of the Philosophy of Life, characteristic of modern society, and would, at the same time, definitely show how ambiguously the notion is used Here one example will suffice. While for most educators Democracy means as much education for everybody as possible, modern practical politicians, trying in their speeches to make themselves out as democratic as possible, sometimes like to boast that they never went to a High School or have never read more than a dozen books The various uses and misuses of the term Logic itself, mentioned above, also give a good illustration of this fallacy, for they are due, in a very large degree, to a failure to see and show what Logic is contrasted with.

The logical weakness of this fallacy and the harmful effect of ambiguity on control of the environment are quite obvious, without any further illustration. But again the question arises "Why, if this is so, is the fallacy so popular and often so convincing?" The reason is that, though ambiguity is one of the greatest faults in logic, and probably the chief root and source of all other mistakes, nevertheless, in the realm of appreciation and evaluation, it is almost the most necessary and welcome element. An opportunity for individual interpretation of data and for subjective, creative reconstruction of the presented object is the core and essence of any æsthetic or, even more broadly, of any appreciative experience. This tendency to attach an individual, personal meaning to a given symbol or situation definitely requires a certain degree of ambiguity in any statement, if it happens that the statement is an object of appreciative experience. Therefore, wherever the element of evaluation, desire, anticipation, or emotion is strong, an ambiguous statement has, in most cases, more chance of appealing to a large crowd of people, because it is so easy for every member of the crowd to see in a statement exactly what he wants to see, to enjoy it as though it were his own, and to love it, because it is a product of his personal creative effort. It is by no means accidental that the three oldest and most influential churches of European civilization—Hebrew, Roman Catholic, and Greek Orthodox—use in their rituals languages only partly understandable to their congregations. The part of the service not understood is probably the most precious part of it for each individual member of the congregation, because he fills it with his own ideas, ideals, hopes, and aspirations, so transforming the group life, to a large extent, into his own personal life. All big social movements have as their slogans something very vague, very ambiguous, and in most cases incapable of undergoing definition without loss of significance and appeal—"Liberté, Egalité, Fraternité", "World safe for Democracy"; "For our Fatherland"; "My Country", "Our God", "Universal brotherhood"; "Social Revolution", "Communism"; "Lenin"; "One hundred per cent Americanism"; "Democracy", "Truth"; "Justice"; "The right cause"; "Independent Thinking"; and the like. All these symbols can unite a considerable number of people around themselves only because they are so ambiguous—subjectively so rich in meaning, and objectively almost meaningless.

If neglect of the second principle is punished by ambiguity, then neglect of the third, the principle of continuity, brings with it destructive dogmatism, one-sided exclusiveness, and intellectual intolerance. The principle runs: "*The essence of dynamic reasoning is the establishment of continuity between two opposite poles of a unit of thought which tends to terminate in a realization of their qualitative identity Efficient thinking must start with an assumption of continuity in potentiality, and work for its actual realization*"

To what hopeless deadlock neglect of continuity may lead our reasoning, is illustrated very well by the educational lawsuit between "interest" and "discipline," found in Dewey's essay, *Interest and Effort*, discussed in detail in a foregoing chapter How broad the range really is, and how great the number of problems is, where we might easily lose our way if guided by the old absolutistic Logic, is seen in the above-given list of pairs of opposites, mentioned and discussed in the spirit of dynamic Logic by Dewey in his *Democracy and Education*. How effectual the principle of continuity is, has been shown in the discussion on *Interest and Effort* and may be seen, furthermore, in any chapter of *Democracy and Education*.

Outside of education, probably in no other field of human experience has the principle of continuity been so neglected as in pure philosophy, and therefore nowhere else is its application more needed Without any danger of exaggeration, one can say that most of the great and eternal fundamental problems of philosophy owe their existence to the same unrestricted adherence to the old Static Logic. In the controversies of empiricism versus rationalism, of spiritualism versus materialism, of naturalism versus mysticism, of idealism versus realism, of dogmatism versus scepticism, of determinism versus free-will, of egoism versus altruism, of pessimism versus optimism, and the rest, the seeds of all difficulties lie, not so much in the nature of things and the nature of the human understanding, as in the peculiar ways of our traditional reasoning. The problems are much more logical than metaphysical. In that sense they are mainly artificial; they are artificially created by inserting between things and mind the deadening instrument of static Logic The only way to get rid of the problems is, not so much to solve them, as to dissolve, or, in other words, to destroy them, by replacing the obsolete organon of static Logic with the more comprehensive instrument of dynamic Logic. Holding to static Logic, we are destined only to repeat without end, again and again, the experience of the famous blind men of India who wanted to know what an elephant was like One of them felt the elephant's trunk and said that an elephant is like a snake, another touched its tusk and decided that an elephant is more like a lump of marble, and the third took hold of its tail and insisted that an elephant is like a piece of rope. All three argued long and could not agree. One of the greatest scientists of the last century, if the writer is not mistaken, Lord Kelvin, once said that it would be easy to create something like an anti-physics by a consistent developing of all the implications and bearings of a few physical principles, leaving all others out of consideration. As far as the writer's information goes, nobody has actually attempted to construct this kind of anti-physics, but the whole development of philosophy has been almost nothing but the creation, remodelling, patching, and mending of peculiar systems of anti-metaphysics contradictory to one another and to experience, and based on the absolute acceptance of certain data and the complete neglect of others But, if this is so, why has the principle of continuity not found its way into common human reasoning, and why has it not been universally accepted? One reason, and in all probability the main one, is the fact that, as above indicated, for all practical purposes and from the point of view of controlling environment and of communicating statements, acceptance of the continuity principle, without the application of certain quantitative indices, would result in even greater confusion and lower efficiency than would strict adherence to static Logic. For instance, the division of all human beings into two quite separate groups of persons, completely responsible and entirely irresponsible for their actions, is certainly for practical purposes much superior to a mere admission, without further modifications, that all human beings, from the new-born child to the man in his prime, are always both responsible and irresponsible for their actions.

This leads us to the fallacies resulting from a violation of the fourth principle of dynamic Logic—the principle of quantitative indices, which reads: *No statement has any definite meaning without a certain quantitative index. In efficient reasoning, the quantitative value of any unit of thought must be explicitly indicated, preferably in terms of objective continuous scales between the two poles of the opposites.*

The fallacies may appear in two forms. Accepting the continuity between any given two poles, but failing to distinguish a quantitative difference in degree between the steps of the continuum, one may think of all the steps either (*a*) as possessing the characteristics of the middle step of the continuum, or (*b*) as possessing the characteristics of one of the poles. A mistake of the first kind brings with it vagueness, indefiniteness, and apathy of reasoning and makes it sterile and incapable of guiding our actions. When many mistakes of this kind accumulate and this type of reasoning becomes habitual, everything in life around us begins to look shapeless, indefinite, foggy, and shrouded by clouds of twilight and gloom, in which, as the saying goes, all cats look grey. When it becomes overwhelming, this defect of reasoning is largely responsible for that intellectual despair and contempt for reason which drove ancient Solomon to observe, "He that increaseth knowledge increaseth sorrow," and the modern philosopher, Anatole France, to confess that he prefers "the folly of passion to the indifference of wisdom."

If the first kind of fallacy produces statements which, though true from a certain point of view, lead to nothing and are nearly meaningless, the products of the second kind of fallacy, on the contrary, convey definite meanings but false ones, and do lead, but in a wrong direction. By applying to the terms of a continuum at one pole the characteristics of the opposite pole, they give a distorted picture of any situation. They smuggle in wrong assumptions and impose false implications.

A good sample of this fallacy is the strong prejudice against apples from churchyard trees, which is common in many countries. If asked, "Why?" people usually answer, "Well, I just hate taking apples like those. I would feel like eating a corpse. You see, they grow so well because of the graves around." The logic behind the answer (of which they are probably not aware) is a defective logic of continuity (in this case, in time) between the substance of the corpses in the grave and the substance of the apples, which in all other respects is quite acceptable. For certain emotional reasons, people pay special attention to the "grave" pole of the continuum, and then attribute the characteristics of the terms of the continuum near that pole to the terms close to the opposite pole. So, by paying no attention to the degree of "corpseness" in the substance, as it were, they are definitely misled by the idea of continuity. The same mistake, but probably in a form easier to notice, is at the bottom of the following situation. In a European city, if the writer is not mistaken, in Berlin, the sewage is purified by a process which is mainly biological, very gradually but extremely efficiently. The method works so perfectly that visitors to the works are first shown the very repulsive-looking and foul-smelling liquid, and are then led through all the works, observing the continuous process of purification step by step, and in the end are offered a drink of the liquid from the stream, to be convinced that it really is very good, clean, and wholesome water. But usually very few dare to take the drink. Here we have the same mistake as in the case of the churchyard apples. The continuity is so apparent that it is only natural for untrained minds to transfer the characteristics of the terms at the one pole to the terms at the other pole, unconditionally. The same logical fallacy, but not in such a noticeable form, underlies the controversies on evolution so much discussed at present. The problem of evolution is certainly not only a scientific problem. Neither is it only a question of the truth of certain scientific statements. If it were so, the problem of organic evolution would hardly attract more attention and controversy than any other scientific problem of the same kind, such as the problem of the origin of oil, which is much less satisfactorily solved by science but nevertheless is not discussed at all outside the small body of specialists What is really behind all the passions and polemics on evolution, in the writer's mind, is well represented in a recollection of his school years. One of his schoolmates, a boy of rather unfortunate mental and physical make-up, once, in a class in religion, without any introduction, quite abruptly asked the teacher, a priest, "Is it true that man is just an offspring of the monkey ?" The witty priest, himself orthodox and a fundamentalist, looked at the boy attentively for half a minute in complete silence, and then answered. "When looking at you, my boy, I am inclined to think that it is probably true" And this "monkey-question" for the great majority is the real issue of the evolution controversy. For most people, the real problem seems like the question: "Am I, are my mother, my wife, and my children, nothing but slightly advanced monkeys, or not ?" And what bothers and perplexes them, when they are forced by the evidence to accept evolution, is the same logical fallacy as in the two previous cases. They are made to see the continuity between "monkey" and man or between other animals and man; then they ascribe the characteristics of the lower pole to the higher pole of the continuum, and certainly feel uneasy and misled. Evolution as a social problem is not a scientific or religious or ethical problem. It is mostly and primarily a logical problem. When a quantitative index in one or another form is introduced, and its full meaning and significance are realized, then all other concomitant problems of an uncomfortable and bothering nature will disappear automatically.

In this case the mistake is usually committed by the people who do not trust science much, and are often even hostile to it, but there are probably as many victims of the same fallacy among people who have an unconditioned faith in the unlimited power of science. Even now, for instance, one may meet educated or, generally, half-educated people who would say that mental life is nothing more than a combination of physical and chemical reactions. Statements like this are most often made by people who have been interested mainly in the natural sciences. For one reason or another, their attention was mostly attracted by the behaviour of lower animals, in which the mental processes are either almost completely absent or very hard to investigate, and consequently, when seeing the continuity of life from the amœba to man, they apply the characteristics of the lower end of the scale to the higher, and in this way repeat, step by step, exactly the same fallacy as that of the churchyard apples

This illustration deals with a phenomenon which may be called "logical inertia." When in a certain logical continuum the experiences of an individual are mostly limited to a region near one pole, then a tendency is formed to bring into the habitual region the terms of the continuum which would normally lie outside it, in other words, to displace, to move the whole scale of the quantitative indices in the direction of the stronger pole. This disinclination to leave the habitual region, or what is called here "logical inertia," makes the individual rate the quantitative value of any incoming experience (within the given continuum, of course) too much in the direction of the inertia pole. Most of the people with a certain field of experience much more extensively exercised than other fields, in other words, so-called specialists, usually show this logical inertia quite pronouncedly. A teacher finds in children many more things to correct than a non-teacher; a student of sex sees manifestations of sexuality where other people would see nothing of the kind, a psychiatrist would apply the epithet abnormal to behaviour which a layman would not even consider queer; a prosecutor sees a potential criminal in everybody much more readily than does an average man of the street; and so on. The tendency to dislocate the scales of continuity is connected not only with a certain definite profession or occupation, but it is also, generally speaking, a result of the predominance of any one kind of experience over its opposite Thus, a person who has passed through the experience of a narrow escape from a burning house will often consider all modern buildings very unsafe in case of fire, a habitual liar who is conscious of his failing will suspect any statement he hears of being a lie; a very honest person, on the contrary, is often a victim of his own credulity; and so on.

The tendency towards extreme materialism and towards neglecting or even denying the very existence of mental life, often met with in people engaged in a study of the mechanisms and primitive forms of life, has been mentioned above. The logical counterpart of it is the fallacy of primitive animism Primitive people, having practically no experience of mechanisms, but plenty of introspection, have a tendency to neglect mechanical explanations and interpretations of happenings around, and see highly developed life nearly everywhere. Logically, it is exactly the same mistake as the extreme materialist commits, the difference being only in the direction of the slide of the scale. The modern forms of the logic of primitive animism, to be found in Christian Science and New Thought, provide a good illustration of the kind of fallacies here considered, and may well conclude the list of them. The adepts of the new philosophy of life first, quite legitimately, construct a continuum between certain feelings, attitudes, ideas, and actions which are considerably under our immediate control, on the one hand, and much less subjective elements of experience on the other, and then, in a very misleading way, treat all terms of the continuum as if they were all highly subjective terms. The error here is again the fallacy of the churchyard apples.

Going back to the first form of the violation of the principle of quantitative indices, mentioned above, but not discussed in detail, it is worth while at once to notice certain of its specific features. This kind of fallacy nearly always takes the form of a rather vague and general, so-called sweeping statement, and is used to refute any collateral particular statement Though the sweeping statement by itself usually *looks*, at first sight, rather innocent, with nothing at all striking about it, nevertheless when properly, or, more truly, improperly handled, it possesses a most remarkable power of invalidating the corresponding particular statements Illustrations will show better how it works For instance, if somebody should say, "I think Mr So-and-So is quite an honest man," the answer to that may be something like this: "If you earnestly say that Mr So-and-So is quite an honest man, I shall certainly do my best now to meet and know him I must confess that almost from childhood my aspiration has been to find a really honest man, and so far I have failed definitely. My whole experience has taught me that all of us are human indeed, and that everybody has his weaknesses. The old Adam is too strong in all of us. Probably it is not all our fault, maybe something is fundamentally wrong in our social organization, or in the spirit of life around, but do you really believe that this Mr So-and-So, having lived in our time, and not in the millennium, not among the blessed souls of a fanciful Utopia but among the specimens of *Homo sapiens* as they actually are—do you honestly believe that really, through all his life, he never lied, never broke his promise, never had any compromises with his conscience, never deserted a fight for a good cause when it was getting too hot? If you honestly believe it, call him an honest man, but I will never believe it." An oration like this, especially if presented in a more elaborate and eloquent form, would in many cases be a success. Putting aside the emotional appeal, the argument *ad hominem*, which is, as always, only a catalytic factor and not actually convincing, the logical skeleton of the argument would be like this: "Practically there are no absolutely, exclusively, one hundred per cent honest people. All people actually existing (that is, between one and ninety-nine per cent), cannot therefore be called honest. Therefore Mr So-and-So is not an honest man." The fallacy of this reasoning lies in considering all people except those who are one hundred per cent honest as one homogeneous group with the same characteristic of being "not honest" people. If it is practically true of the people who are one to five per cent honest, it is quite wrong about those who are ninety-five to ninety-nine per cent honest, and considerably misleading about the central group around fifty per cent. Thus the essence of the fallacy is again neglect of the quantitative difference of the terms of a continuum.

It is interesting to see that the same general statement and the same method of reasoning, with a little modification, can be used to refute a quite opposite statement. Suppose that someone says: "After taking into consideration everything that I know of him, I should say that Mr So-and-So is a dishonest man." A person who would question the statement may present his case thus: "I wonder why you have labelled Mr So-and-So a dishonest man? I would not be so severe on him. I know all you know of him, and I know that he did many rather bad things, but where, tell me, can you find a perfect human being? They say that only God is without sin, but all of us mortals are weak flesh, and nobody is free of weak points and demerits On the other hand, I am sure that in many respects he would at least be as reliable and as good as many so-called 'virtuous people' and 'good citizens' No! Thinking this all over again, I would never brand him as a 'dishonest man' and so ostracize him from our own crowd, which, after all, is by no means too righteous." The fallacy here is exactly the same as above: the lack of quantitative discrimination.

Probably the device as presented here in a simplified and abridged form does not look very convincing, but it has been used for centuries by criminal attorneys all over the world, especially when the crime of their clients was apparent, and the persistence of the practice testifies to its success.

Generally speaking, it is safe to say that, outside of court debates, this fallacy is also one of the most common, probably the most common error of our reasoning. All modern discussion in every field, with the exception probably of the exact sciences, is full of it. A good American in a lively discussion with a Soviet sympathizer puts before him the fact that in Soviet Russia all papers are published by Communists or under strict supervision of the government, and no freedom of the press exists; and the young man will answer, "Yes, assuredly in Russia they also have certain regulations about publications, but it is so everywhere. Where would you find complete, entirely unrestricted freedom of the press? You are so proud of civic liberty in your country, and call it the land of freedom, but have you absolute freedom of the press and speech? No! Haven't you read of books confiscated by the police? Don't you know that you cannot mail certain Birth Control publications? If you would publish here certain rather expressive posters and pictures on religion and Christianity which they print in Russia, you would be prosecuted by the court, and I do not think you would protest against it very much. So, too, in Soviet Russia they have certain regulations about the press and publication, exactly as they have in this country and everywhere else, and therefore all your charges that Soviet Russia is undemocratic have no foundation at all except your prejudice against it."

A fundamentalist accuses an extreme modernist of too free and fantastic an interpretation of the Bible, and of considering nearly all things in it as symbols, not statements of facts. Then the modernist answers: "So you insist that symbolic interpretation of the Bible is wrong, and we must understand everything in it literally? But do you yourself really stick to that and take everything literally? Do you believe that God has eyes literally as we have them, right hand and left hand, voice and consequently vocal chords, and so on? You say, 'No.' So I see we are both in the same boat, with only one difference—that you reserve the right to a symbolic interpretation for yourself only, whereas I am not so exclusive."

Two good friends, educators, one a little radical, another a bit conservative, discuss a school they have just visited. The radical: "I think they do pretty good work in that school. There is only one thing I would object to, that is that everything is a little too definite. The course of study is rather rigid, they have definite standards for home-work, the routine is all cut-and-dried. It looks as if the children do not have much chance for spontaneous activities and their own projects. In other words, it seems to me, as they like to say now, that there is too much imposition in this school." The conservative: "Oh, stop it, please! I am so sick and tired of all these talks of imposition and spontaneous activities. All that is just a wretched misunderstanding! Have you ever actually seen a school with these 'spontaneous' activities and without imposition? You certainly have not, and, what is the worst, you never will see it, because a school without imposition is what they call in Logic a contradiction in terms. If a man is engaged in education, it means that he fosters certain changes in children and discourages others. This means that he imposes. Once you admit children to a school—any school—you present to them, propose to them a certain environment, and by doing so you already impose on them that environment and all the changes it may produce in them. You cannot possibly escape imposition in education, because education is imposition, and therefore, obviously, to object to imposition by a school is just ridiculous," and so on, and so on. It would be useless to multiply illustrations further. Nearly any copy of any newspaper, any magazine issue, and any book will contribute its share. A thorough analysis of the press as a whole will supply as many illustrations as one could want.

At the end of this brief review of the fallacies resulting from a violation of the principles of dynamic Logic, the reader should be reminded again that the types of fallacies described above are not separate and independent units, but only terms of different continuums, and that therefore there are many fallacies which are something like transitional forms or cross-breeds between the types mentioned above The analysis of the above fallacies shows how the principles of dynamic Logic can be used to reveal the errors of our reasoning The next problem to be considered is, how, in accordance with dynamic Logic, our thinking must be organized in order to prevent and correct possible mistakes.

The general suggestion will naturally be . apply dynamic Logic consistently. Like all general rules, it is much simpler to state than to put into practice. Let us see what problems one may meet when following dynamic Logic rigorously.

The first two principles are so simple that they do not require any special explanation and instruction on how to apply them. As illustrating their actual use, the list of pairs of opposites, Ch IV (p. 85ff.), may be taken.

The principles of Continuity and especially of Quantitative Indices are not so obvious. Their practical application may require a certain rather complicated procedure, a certain technique. The best way to give an idea of this technique will be to describe the actual construction of a quantitative scale for the mental activity-physical activity continuum, made by the present writer. From the very outset the scale was not supposed to be a final, working scale. The purpose of its making was only experimental and illustrative—to give some idea how scales of this kind could be made. The co-operation of thirty graduate students of Teachers College, Columbia University, who acted as judges, was enlisted. All were members of advanced classes in the Philosophy of Education. Each of the judges was given the following instructions and list of situations, prepared by the writer:

> This is not a test, but a request for your co-operation. Your judgment is solicited for a piece of scientific research.
>
> You will be given descriptions of several different situations involving elements of both *mental* and *physical* activities. Consider only the proportion of *mental activity-elements* to *physical activity-elements*, neglecting all other possible elements. Arrange the given situations in order of increase of percentage of mental activity-elements and corresponding decreased percentage of physical activity-elements. Begin with a situation where the percentage of mental activity-elements is smallest and the percentage of physical activity-elements is greatest, and call this number (1). Number each of the other situations in order, putting its number in the upper left corner of each slip.[1]

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[1] The situations were given to each judge, both put together on a sheet as they are printed here, and also each situation on a separate slip of paper. The writer's impression is that judges who chose to use separate slips rendered more correct scores.

Per cent

1.[1] No..... . . . .
A working-man digging in road construction.

2. No..... . . . .
A taxi-driver "on the job" in a big city.

3. No..... . . . .
An amateur sitting in a theatre completely absorbed in the performance of his favourite opera.

4. No..... . . . .
A singer known for his deep interpretation of music, singing before an audience.

5. No..... . . . .
A famous pianist playing at a concert.

6. No..... . . . .
A sculptor actively at his work.

7. No..... . . . .
A tennis-player playing a responsible game.

8. No.... . . . .
A traffic policeman at work on a busy corner in New York.

9. No..... . . . .
An elevator-starter at work in a big hotel.

10. No..... . . . .
An experienced typist at work.

11. No..... . . . .
A turner making a piece of machinery from a drawing.

12. No..... . . . .
An experienced maid at her everyday work in the parlour.

13. No..... . . . .
A working-man pulling the rope of a pulley lifting a load not too heavy.

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[1] The numbers were not put down on the sheets actually given to the judges. They are added here to identify the situations.

Per cent

14. No..... . . . .
    A longshoreman alone on a pier rolling a barrel from one place to another.

15. No..... . . . .
    A boy reading an interesting book.

16. No..... . . . .
    A composer in his study sitting motionless in an easy-chair deeply absorbed in the music of his next creation that just begins to take definite shape in his mind

17. No.... . . . .
    A farmer carrying a bag of flour on his back from his barn to his house.

18. No..... . . . .
    A dish-washer at work.

19. No..... . . . .
    A student who has memorized two three-digit numbers and is multiplying them mentally.

20. No.... . . . .
    A couple playing a game of chess.

It took an average of 10-15 minutes for the judges to arrange the situations in the requested order When they were through with this part of the experiment, they were given the second instruction.

> For each situation write, in the *upper right* corner the approximate percentage of the mental activity-elements which, in your opinion, is present in the particular situation.
>
> It is assumed that mental activity-elements and physical activity-elements together make 100 per cent.

To write down the percentage required about 5-10 minutes. Then the lists of situations were returned to the writer. All the material was tabulated (Tables I, II, and III, pp. 170-2), and for each situation the median of its standing, as determined by the judges, was calculated (Table III, p. 172). Put in order of their medians, the situations formed a mental activity-physical activity continuum.

The next problem was to express the value of each situation in terms of percentage. As can be seen from Table II (p. 171), the distribution of percentage is much less uniform and more confusing than the distribution of rating. To be sure, this is to be expected, for adjudging percentages is generally a much harder and more arbitrary operation than arranging given examples in the order of decrease or increase of a certain characteristic. There could be many different ways of dealing with the percentage. Taking into consideration the merely illustrative character of the whole experiment, the writer chose the simplest and most expedient method He took the average percentage for two extreme situations, which happened to be 5 per cent and 97 per cent, and made the lowest median, 2, equivalent to 5 per cent, and the highest median, 19 20, equivalent to 97 per cent. Then all the other medians and their corresponding situations acquired the percentage value as shown in the last column of Table III (p. 172).

Expressing the first half of the situations in percentage of the mental activity-elements and the second half in percentage of the physical activity-elements, the whole scale can be represented in the form of Graph I of Table IV. A glance at the graph will be enough to make one see that in the pairs 1-2, 13-14, 17-18 the situations practically duplicate one another. Omitting one duplicate in each pair, we at last get our scale in the final form—Table V (p. 174). In graph form it is also shown in Table IV (p. 173), Graph II.

Though the scale is primarily illustrative, it can also be used for actual quantitative evaluations of different activities from the point of view of the continuum. Let us take an illustration which will show how generally scales of this kind can be used. Suppose that we are discussing, from the point of view of the mental-versus-physical-activity-continuum, the life of a schoolboy. Suppose that we are especially concerned with the boy's following activities: (*a*) reading his history preparation; (*b*) pushing with all his might against a door that sticks; (*c*) reciting a poem at an assembly; (*d*) day-dreaming of his future exploits as an Arctic explorer; and (*e*) playing base-ball. If we have no quantitative scale, we can adopt one of the following four positions: all the activities are mental; all the activities are physical, some of them are mental and some physical, all of them are both mental and physical. The first three positions, representing static reasoning, would put all the cases either in one big lump or into two sharply divided groups. We know that both groupings are wrong and not discriminative enough. The last point of view—dynamic reasoning—is generally right, but not discriminative enough. It puts all the situations into one undefinite and shapeless group. If, however, we apply our scale, then we can easily tell that (*a*) reading the history preparation is about 82 per cent mental-physical, (*b*) pushing the door, about 6 per cent; (*c*) reciting a poem, about 71 per cent, (*d*) day-dreaming, about 97 per cent; and (*e*) playing base-ball about 45 per cent.

It is very probable that quantitative evaluations like these will face criticism in form of a question like this: "But how on earth do you know that reading is 82 per cent mental-physical and dish-washing 15 per cent? All that percentage evaluation is purely arbitrary, and not obligatory to anybody." The criticism is not strong. We shall here put aside the problem whether the indices are "purely" arbitrary or not, though, being a composite judgment of a select group, they can hardly be purely arbitrary. For the sake of argument, let us admit that they are considerably arbitrary. The arbitrariness of the indices by no means makes them useless or misleading, so far as we know the situation for which the indices stand

and so far as all concerned agree to use the same indices for the same situations. In fact, all our scales are arbitrary. There are no special intrinsic reasons for dividing an hour into sixty minutes except certain considerations of expediency, but so long as we all agree to take one-sixtieth of an hour for one minute no confusion arises. There are three scales of temperature in use, Centigrade, Fahrenheit, and Reaumur, all arbitrary. If, instead of water, we took gasolene or mercury or helium as our standard, we should have quite different scales, but as arbitrary as our present ones All the scales, nevertheless, can be workable so long as the actual situations for which units of the scales stand are known and agreed upon.

Another criticism of the scales may be that they are not objective, but subjective. If it is said about any measuring scale or process that it is subjective, it practically means that in an attempt to determine a certain situation in terms of the scale, different people would very likely get different results. It is obvious that there is no such thing as an absolutely one hundred per cent objective scale or measurement Any instructor in Physics knows that, if a student is given the problem of exactly measuring several times even such a simple thing as the volume or weight of a small metal ball, and if the student reports that in all his measurements he gets exactly the same result, it means that he did not really perform the required measurements Thus we have to judge the objectivity of continua in the spirit of continuity and relativity. As compared with thermometer scales or measurements of electricity, scales like those of the mental-physical activity continuum are certainly less objective and exact Since we have thermometers, it would be absurd to construct continua like boiling water, temperature of human body, melting butter, lukewarm water, cold water, ice-water, and the like, but if we had no thermometers it would not be at all absurd, but very helpful. Unfortunately, there are too many cases where we have no thermometer-like scales, and here the continua are much more objective and exact as means of quantitative evaluation than any modifiers of speech in common use As soon as a corresponding science constructs a more objective scale for measuring the phenomena of a continuum, then the continuum must be dropped, but as the situation is at present, there is a very large number of problems where continua would now be the best measuring instrument

As was mentioned above, the scale is only an indication of a starting-point in the development of the quantitative evaluation of thought-units. There are many problems to be considered in connexion with it, one of the greatest of them would be, for instance, how to find a method of combining two quantitatively modified judgments into a higher unit of thought, or, in other words, the method of quantitative treatment of inference.

Going back to our experimental scale, Table V, we can see a few points in which it may be improved immediately. For instance, the judges could be better selected. Judges play a very important part in the construction of the scales. The value and reliability of the scales depend in a very large degree on the quality and quantity of the judges. The more judges we have, the more definitely the general tendency is expressed Even more important than the number of judges are their qualifications. They must be persons of very extensive and very well-organized experience in the field of the continuum in question. In other words, they must be high-class specialists and experts on the subject-matter of the scale.

The graph of the scales shows that in certain parts of the scale the interval between the steps is too great, as, for instance, between steps 4 and 5 and between 11 and 12. This makes the scale insufficiently discriminative. To eliminate this defect, more steps must be inserted by the same procedure as was used in the first experiment.

In conclusion, a few words must be said about the use of the scales. There are two possible mistakes to be considered: one, as mentioned above, is that of failing to use them when they are needed, another is that of using them when they are not needed. It would be impossible in an inquiry on the influence of Na-ions on the behaviour of Paramœcia to go on successfully with only the terms "hot, warm, cold, salty, fresh, very salty water." On the other hand, it would be absurd if, instead of saying to a waiter in a restaurant, "I like my soup very hot and not very salty," one said, "The temperature of my soup must on no account be below 97° C and the content of NaCl in it must not be more than one-tenth of molar concentration."

In the same way, it is almost impossible to balance and describe accurately the proportion of mental and physical elements in school activities by using only the terms "physical activity, mental activity, more mental than physical, more physical than mental," and so on; while it would be perfectly ridiculous if, instead of saying to a heavy and clumsy maid busy with housework, "Look out, and pay more attention to what you are doing," you said, "Try to increase the mental element of your activities to at least twenty per cent of the standard scale."

TABLE I

POSITIONS, ASSIGNED BY THIRTY JUDGES, TO THE MENTAL-PHYSICAL ACTIVITY CONTINUUM SITUATIONS (IN ORDER OF DECREASE OF MENTAL ACTIVITY-ELEMENTS)

JUDGES	SITUATIONS																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	3	10	19	16	17	18	9	11	6	8	12	7	2	1	13	20	4	5	14	15
2	3	9	18	15	13	14	11	10	8	7	12	6	1	2	16	20	4	5	19	17
3	4	9	17	13	15	14	10	8	6	11	12	7	1	3	18	19	2	5	20	16
4	3	11	20	15	12	13	8	14	7	9	10	6	1	4	17	19	2	5	18	16
5	4	8	12	15	14	11	10	16	6	9	13	7	3	2	18	19	1	5	20	17
6	2	9	19	16	15	13	10	11	7	8	12	5	1	3	20	18	4	6	17	14
7	5	13	14	15	16	17	11	12	3	4	9	7	6	8	10	20	5	2	19	18
8	1	9	17	13	14	15	8	11	7	10	12	6	4	3	18	19	5	2	20	16
9	1	8	12	13	15	14	10	11	5	9	16	7	6	2	18	20	3	4	19	17
10	1	11	12	13	14	15	16	10	4	9	6	5	7	8	17	20	3	2	19	18
11	3	8	18	15	14	13	11	10	7	9	12	4	5	2	16	20	1	6	19	17
12	2	10	17	14	13	15	11	9	8	7	12	6	1	5	16	20	3	4	19	18
13	1	3	17	15	7	12	10	14	9	6	11	4	8	3	18	20	2	5	19	16
14	1	10	16	15	13	14	12	11	9	7	8	6	4	2	18	20	3	5	17	19
15	1	6	17	14	15	12	11	13	7	8	10	5	2	3	18	19	9	4	20	16
16	4	11	9	18	17	19	14	12	7	8	13	6	1	3	16	20	2	5	10	15
17	3	9	17	15	13	14	10	11	8		12	7	5	4	16	20	2	6	19	18
18	7	11	17	13	14	19	10	8	6	9	12	3	2	4	16	20	5	1	18	15
19	1	9	18	16	10	19	14	11	5	7	15	8	4	2	17	20	3	6	13	12
20	1	7	18	16	15	14	8	11	6	10	12	9	5	3	17	20	2	4	19	13
21	5	3	18	14	15	13	12	8	4	10	11	7	2	9	17	20	1	6	19	16
22	1	2	18	17	15	13	10	11	8	9	14	7	3	6	16	19	5	4	20	12
23	6	8	17	10	11	12	9	7	15	13	14	4	2	5	18	19	1	3	20	16
24	3	15	19	11	10	12	8	14	5	13	9	7	1	2	17	18	4	6	20	16
25	5	12	16	19	17	18	9	11	7	10	8	6	2	1	13	20	3	4	14	15
26	1	8	16	17	18	14	12	9	7	10	11	6	3	2	13	20	5	4	15	19
27	1	15	13	9	10	11	12	16	7	8	14	3	2	6	17	18	5	4	20	19
28	3	10	16	14	19	13	11	12	8	7	9	6	1	2	15	20	4	5	18	17
29	1	10	17	15	13	14	9	7	6	11	12	8	5	3	16	20	4	2	19	18
30	1	10	17	15	11	14	7	13	12	9	8	3	6	2	18	19	5	4	20	16

TABLE II

PER CENT OF MENTAL ACTIVITY-ELEMENTS, ASSIGNED BY THIRTY JUDGES TO THE MENTAL ACTIVITY-PHYSICAL ACTIVITY CONTINUUM SITUATIONS

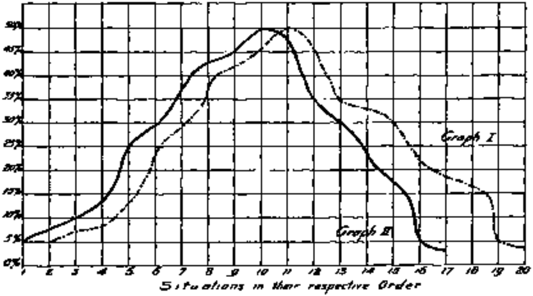
	SITUATIONS																			
JUDGES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	20	55	100	80	90	80	50	60	40	50	70	50	15	10	15	100	25	40	80	80
2	15	60	93	90	85	90	70	70	55	50	80	45	5	10	95	100	20	40	100	93
3	75	90	95	50	50	90	33	30	25	40	50	30	5	10	95	93	8	20	95	85
4	11	60	99	75	65	70	40	67	33	50	55	25	5	75	85	98	10	18	85	80
5	8	73	33	38	60	67	30	32	9	15	55	11	7	6	87	94	5	82	95	85
6	3	20	90	75	70	65	50	60	9	8	70	7	2	5	90	97	8	7	90	90
7	7	56	58	60	65	70	50	15	5	13	42	30	25	35	45	95	20	6	90	75
8	5	50	90	70	71	75	40	60	25	50	65	20	10	10	95	100	10	5	100	80
9	5	35	75	80	80	40	50	75	15	33	80	28	15	1	93	100	5	10	100	90
10	1	6		8	8	8	10	5	2	5	3	2	7	2		12	1	1	12	11
11	10	25	92	80	70	60	45	40	20	30	50	14	15	10	85	95	8	18	94	90
12																				
13	5	15	88	81	25	60	40	80	50	30	45	15	26	11	90	95	10	16	92	85
14	5	16	93	90	70	80	50	80	10	10	20	5	10	5	95	95	10	10	90	90
15	2	23	85	70	75	55	50	60	25	40	45	20	2	5	90	90	40	15	98	80
16	15	60	35	81	80	90	70	61	30	31	65	21	2	4	76	95	3	20	90	75
17	7	15	80	50	40	48	20	25	14		35	12	9	8	75	95	6	10	90	85
18																				
19																				
20	10	25	90	86	85	80	30	50	20	40	55	32	16	14	88	48	12	15	95	75
21	10	18	92	40	45	38	35	60	9	20	30	14	6	8	19	95	5	12	93	84
22																				
23	20	30	85	40	70	70	50	60	63	50	60	8	6	10	90	96	5	7	98	80
24	6	95	100	80	85	80	20	10	16	60	20	15	2	4	90	100	5	9	100	75
25		60	80	80	71	75	50	25	5		25	25	1	1	80	99	15	25	80	75
26	3	90	20	75	86	70	65	50	20	50	60	15	10	20	65	90	10	10	70	85
27	2	80	70	40	50	60	85	85	9	30	75	5	3	8	88	90	3	5	95	92
28	3	50	96	55	100	70	55	65	20	11	25	10	1	2	95	99	30	5	98	97
29	3	42	90	73	62	63	40	32	30	50	60	36	12	8	73	96	10	6	95	92
30	3	70	100	90	75	90	50	90	85	65	60	25	45	10	100	100	45	30	100	95

TABLE III

FREQUENCY DISTRIBUTION OF THE POSITIONS OF THE MENTAL ACTIVITY-PHYSICAL ACTIVITY CONTINUUM SITUATIONS AS ASSIGNED BY THIRTY JUDGES

Position of Situations in order of increase of Mental Activity-Elements																				A Positions of Situations in the Original Order	B Median Score	C Corresponding per cent	D Positions of Situations in Final Order
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20				
23	2	1	1	1	1	1														1	1	5	1
6	7	2	3	5	3	1	1													13	1	5	2
2	10	9	3	2	2		2													14	2.33	6.78	3
4	6	9	6	4																17	2.50	8.33	4
1	4	1	9	9	6															18	4	15.00	5
—		1	3	5	4	9	2	1												12	5.66	24.58	6
1			2	3	6	9	5	2			1									9	6.33	28.14	7
—			1		1	5	5	8	5	2		2								10	8.33	38.1	8
	1				1	1	5	7	6	4	1	2		2						2	9	42.45	9
						1	4	4	6	6	4		2		1					7	9.75	46.34	10
						2	3	2	3	10	3	3	2		1					8	10.4	49.34	11
					1		3	3	2	3	11	2	3	1	1					11	11.2	54.33	12
										1	4	5	10	1	1	1	2	1		6	11.5	56.41	13
						1			3	2	1	5	5	7	1	1	1	1		5	11.6	67.06	14
								1	1	1		5	4	10	4	1	1	1		4	14.3	70.84	15
											2	1	[illegible]	4	10	5	4	3		20	15.7	75.29	16
									1			3		1	3	7	10		1	15	16.45	80.15	17
								1			3	1	1		4	10	5	3	1	3	16.5	81.32	18
									1			1	1	1		2	3	11	9	19	18.45	93.00	19
																	1	3	19	16	19.26	97.00	20

TABLE IV



Graph showing the values assigned by thirty judges to the Mental Activity-Physical Activity Continuum situations. The first half of each curve is expressed in Per Cent of Mental Activity Elements, the second half of each curve is expressed in Per Cent of Physical Activity Elements.

The Graph I includes all the situations originally given (see Table III, column D).
The Graph II includes only the situations finally selected (see Table V)

TABLE V

A QUANTITATIVE SCALE FOR THE MENTAL ACTIVITY VERSUS PHYSICAL ACTIVITY CONTINUUM

(Percentage indicates the amount of mental activity-elements)

1	A working-man digging in road construction	5 %
2	A longshoreman alone on a pier rolling a barrel from one place to another	6 78%
3	A farmer carrying a bag of flour on his back from his barn to his house	8 21%
4	A dish-washer at work	15 00%
5	An experienced maid at her everyday work in a parlour	24 58%
6	An elevator-starter at work in a big hotel	28 14%
7	An experienced typist at work	38 80%
8	A taxi-driver " on the job " in a big city	42 45%
9	A tennis-player playing a responsible game	46 34%
10	A traffic policeman at work on a busy corner in New York	49 94%
11.	A turner making a piece of machinery from a drawing	54 22%
12	A sculptor actively at his work	66 41%
13	A singer known for his deep interpretation of music, singing before an audience	70 80%
14	A couple playing a game of chess	76 20%
15	A boy reading an interesting book	82 31%
16	A student who has memorised two three-digit numbers and is multiplying them mentally	95 00%
17	A composer in his study sitting motionless in an easy-chair deeply absorbed in the music of his next creation that just begins to take definite shape in his mind	97 00%

CHAPTER VII

EDUCATION AND DYNAMIC LOGIC

"*Nobody likes to be educated!*"—DEAN WOODBRIDGE

PROBABLY in no other province of human experience can Dynamic Logic be so useful as in education. Curiously enough, in public opinion education generally enjoys the same degree of attention and holds the same position as do diet and general habits of good health in the life of most of us. While we are young and strong and feel well, although theoretically accepting the importance and vital value of rules of hygiene, actually we are not overmuch interested in them, and we are hardly willing to change our other plans for the sake of health. But as we get older or are unlucky enough to feel that something is wrong with our bodily organism, then our interest in hygiene becomes vivid, strong, and active, so that we are ready to sacrifice many nice things to get well again.

The same happens usually with nations in respect of their attitude towards education. As long as the life of society goes on normally, education is generally acknowledged as an important social function, yet it does not attract much public attention; but when some crisis comes, when a depression is felt in the social atmosphere or some political cataclysm occurs, then people turn to education as a remedy and panacea against the evils of the time disclosed by the crisis.

The Great War was certainly a catastrophe big enough to reveal as well as to stimulate, directly or indirectly, many negative sides of modern social, industrial, and political life. And, consequently, the five or seven years following the war witnessed a tremendous revival of interest in education. H. G. Wells, so sensitive to the problems of the day troubling the public mind, has coined the phrase that modern history since the war is a race between education and catastrophe Modern educational thought, indeed, has manifested a remarkable effort to readjust itself to the needs and conditions of the coming new Great Society. But the effort would be even more creative and productive if the technique of our reasoning were itself better adapted to modern needs and conditions Dean Russell, a keen observer of modern educational development and for more than twenty-five years head of one of the largest pedagogical institutions in the world (Teachers College of Columbia University), made some very significant statements in one of his speeches to candidates for higher degrees He said that Teachers College is inclined, so to speak, to "dephilosophize" to a certain degree its Ph.D requirements, and intends to grant the Ph D degree not only for theoretical or laboratory research, but also for successful creative field work. Dean Russell mentioned as one of the reasons for this, the fact that, as things now are, there is a considerable gap between educational theory, or the Philosophy of Education in a broad sense, and the concrete actual problems of educational practice. He expressed the hope that probably in the future a way would be found to connect educational theory and practice more closely, but again he pointed out that, in its present form, educational theory is not of such help to the concrete educational problems of the day as we should like it to be.

This statement may be backed by the experience which almost everybody connected with education has either passed through personally or has observed in others—that is, the experience of an enthusiastic student of education who from books, lectures, and class-discussions comes to actual teaching. Very often he at once realizes that his attempt to put into practice his most favourite theories, apparently so flawless and indisputable, does not bring desired and expected results.

Many explanations of the failure are usually given: a wrong spirit in the traditional school, conservatism of superiors, lack of understanding on the part of the community, bad habits already formed in children by the traditional school, deficiency in one's own personal skill and training, and so on. Even the theories themselves are sometimes blamed for the disappointment, but very often one also hears the following explanation: the theories themselves are very good and inspiring, but, unfortunately, they are just theories, and cannot be applied usefully in real life. Probably all the explanations are, in different conditions correct in varying degrees, but the last one is the most significant from the point of view of the discussion. It brings forth the old dispute between theory and practice.

Strictly speaking, the statement that "a theory is very good but inapplicable" is utterly unacceptable; it is an unmodified contradiction in terms. To say so is the same as to say that "the aeroplane is very, very good, but it does not fly," or "the medicine is wonderful but it does not work." One of the most important functions of a theory is to explain and guide practice, and if it fails to do so it cannot be good. But since it is so often used, the phrase must have a certain significance to the people who employ it. If not taken in a strict verbal sense, the statement usually conveys the idea that the theory in question, in spite of its certain imperfections, has, on the other hand, a certain considerable value, or, more precisely, that it is about 65-85 (excellent-unworthy). What kind of imperfection is usually meant here, and what the cause of the defects is, may be best seen from a few typical illustrations.

Very often one hears a statement like the following: "Theoretically we must expect the temperature in the furnace to be about 1000°, but in practice it is never above 800°", or, "Theoretically a company of infantry with bayonets can easily withstand an attack of cavalry, but actually it is almost always beaten." It is easy to see that in cases like these the reason why an excellent theory "does not work" in practice is the fact that the theoretical statements are accepted as one hundred per cent true, complete in themselves and therefore exclusive of any opposing factors or other contradicting statements. In other words, they are taken in the spirit of static, absolutistic logic, and so we have the fallacy of the blind men of India, where one partial aspect of a situation is mistaken for the situation as a whole.

The other variety of the same fallacy may be illustrated by the following dialogues. Student: "Is it true that if I drop a pin into the ocean at Battery Place, it will make the water in Liverpool Haven rise?" Teacher: "Theoretically, yes, but practically, no" Or this. Student: "Is it true that when we climb Mount Marcy, we change the position of the centre of gravity of the globe?" Teacher: "Theoretically, yes, but practically, no" Here the discrepancy between theory and practice is obviously due to the lack of quantitative indices in the theoretical statements, so typical of static logic When the amount of changes which the theory expects to be produced by the dropped pin and the hiking party is definitely expressed, the discrepancy disappears automatically. Thus in both its forms the conflict between theory and practice is a consequence of the static and absolutistic ways of reasoning, and is easily removed when the methods of Dynamic Logic are applied. Of course this would be very naturally expected, *a priori*, for the problem of theory and practice is only a particular and a rather complicated case of the general problem of general and particular statements, and consequently what was said about the problem above (Ch. V) must be applicable to this case also

This leads us to an explanation of the first words of the chapter, that "probably in no other province of human experience can Dynamic Logic be so useful as in education" Obviously the need for quantitative indices is greatest when the conflict between theory and practice seems to be most probable, and certainly the greatest danger of conflict presents itself when the general statement is a rather broad inclusive generalization and the particular case is quite concrete and specific. And, indeed, probably no other discipline than education presents such a peculiar combination of the broadest possible generalizations and speculation, on the one hand, and the most practical, matter-of-fact, concrete demands on the other.

In one of its aspects education is most closely connected with philosophy. Any educational activity which is above a narrow training of a certain very limited function always involves the deepest problems of the destiny of the human race, of the nature of human nature, of the relationship between the individual and society, and so on. Therefore, objectively, even the narrowest training cannot keep on successfully in the long run, if it completely neglects the fundamental problems mentioned above. Subjectively, too, it cannot possibly be limited by itself, for even the narrowest activity always produces some broader effect on the individual in the form of so-called concomitant learning. In this way even the barest training leads again to the basic broad problems Therefore it is by no means an accidental coincidence that the history of education interweaves itself so much with the history of philosophy. Any philosophy has a tendency to direct our conduct in accordance with its teaching and to reorganize our environment to fit its ideals In this way every philosophy inevitably tends to become an educational system Hence, in its historical aspects, the development of education may be traced from Plato through Locke and Rousseau to Dewey, by the same names as are milestones in the evolution of philosophical thought, so that education may be well described as philosophy put into practice.

But, on the other hand, when educators carry on the task of the realization of the philosophical generalization in actual everyday life, they have to deal with the most unique, the most particular and specific material—that is, human individuals. As no two men's finger-prints are alike, so there are no two individuals the same. Human beings are a most complicated combination of so many different elements that there is no chance of their repeating one another. By the very nature of its problems, being put in the peculiar position of connecting the broadest and most abstract generalizations with the most unique, most individual, and most concrete particular cases, education can perform its task efficiently and with success in the satisfactory control of environment only if it adopts the methods of dynamic reasoning.

If, from considerations of the formal structure of educational problems, we go closer to their content, we can see that most of them may be best expressed as antinomies. Even a very rapid review of the most important problems will make this clear.

Gentile presents, as the most fundamental problem of education, out of which all others grow, the following two contradictory affirmations, which together make the antinomy "(1) that man as the object of education is and must be free, and (2) that education denies man's freedom."[1] Dean Woodbridge, in one of the witty epigrams which make his lectures so sparkling and deep, said, "Nobody likes to be educated," and, indeed, at least in modern education, the problem of spontaneity and imposition is the most outstanding and the most discussed. Again and again educational theory comes back in utter perplexity to the fact that any work of any educational agency involves both spontaneous activity of the person being educated and certain influence and imposition by the agency which educates. Again and again we face the same problem, and do not know how to reconcile the contradictory forces.

Any educational agency deals with human beings, who are simply an incarnated antinomy of "individual" and "social."

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[1] Gentile (Giovanni), *The Reform in Education*, New York, 1922, p. 40

The thing that makes human individuals actually human individuals—human experience—is, again, fundamentally antinomical, for each and every bit of it is an "active-passive affair" (Dewey).

Psychologically, human experience is an output of the interaction of stimuli of the environment (roughly speaking) and of responses of the organism. The interaction antinomically goes in two opposite directions. Stimuli determine reactions, as when, for instance, a burned finger makes a child cry, and at the same time reactions determine stimuli too, as when the red light of a traffic signal stops hundreds of cars on the street, but is nothing to a blind man, or when a false intonation of a double bass in an orchestra does not exist for an enthusiastic amateur, but is an outrage to a trained conductor.

The moving force behind any purposeful educational process, as well as behind any other continuous purposeful activity, is an effort, and it is again "precisely this peculiar combination of conflicting tendencies—tendencies away from and tendencies towards—dislike and longing"[1]

"'Education is Life,' but not something different or separate from it." This is, in a certain sense, the keynote of modern education, and the more it is emphasized, the more rapidly education grows into an independent science and the longer, the more specific, and the more professional is the training required of teachers

And then follows an endless list of minor antinomies: mental activity *v.* physical activity, intellectual *v.* practical studies; physical *v.* social studies; logical *v.* psychological, work *v.* play, and so on, and so on.

The practical significance of all these antinomies is obvious, and leads us inevitably to the acceptance of statements such as: any educational activity is both spontaneous and imposed, individual and social, dislike and longing, mental and physical, work and play, and so on.

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[1] Dewey, *Interest and Effort*, p. 49.

For the classical static Logic, with its "either B or non-B" and *tertium non datum*, statements like these and, generally, all antinomies are something very hard to deal with, if not wholly impossible. It tries to expel them from the body of logically legitimate propositions either by labelling them as paradoxes, or by saying that they are self-contradictory and therefore absurd, or by proclaiming them to be "transcendental," in other words, outside our rational world of experience. But all such disqualifications, come back to static Logic itself, like a boomerang, accumulate into an overwhelming load, and form a formidable *testimonium paupertatis* for it But to Dynamic Logic paradoxes are quite normal, quite acceptable statements, which lead to the better understanding and more precise estimation of events in our world of experience. Antinomies are also one of the most powerful tools of dynamic reasoning, and therefore it is quite natural to expect that Dynamic Logic will deal with the problems of education more efficiently than the traditional static Logic

In the face of that flux of antinomies, and in view of such a separation between general and particular statements in education, the imperative need for quantitative scales such as have been suggested above is quite obvious, but the introduction of the general method and spirit of Dynamic Logic into educational reasoning may be of great value also. To what degree dynamic reasoning can be helpful in education will be well illustrated by the development in the evolution of educational thought of the theory of transfer of training.

The problem of transfer of training is one of the most fundamental problems of education. In Bode's words, "as usually stated, the doctrine of transfer means that mental power or mastery gained in one subject or field of activity is applicable to any other."[1] In less technical terms, the problem of transfer deals with such questions as, whether the study of mathematics will make the later study of Latin easier, whether learning to play the violin will help later in learning to play the 'cello; etc. The doctrine of transfer answers in the affirmative, its opponents in the negative. Usually the end of the seventeenth century and John Locke are held responsible for the extreme form of the theory. Says Charters "It was at this time that Locke, the philosopher and psychologist, crystallized the idea, germs of which are found scattered throughout the writings of the great educators before his days, that mental training could be transferred wholesale from one subject to another. The attitude was more or less generally accepted and unchallenged until our century. At the beginning of the twentieth century the first serious attack upon the claim of wholesale transfer was made by Thorndike, and his criticism has since been elaborated by many investigators. Since that time the educational world has been superficially divided into three classes. Naturally there are those who view any attack upon the transfer of training with suspicion and in some cases with alarm. There is a second group, of very large proportions, that maintains essentially that there is no transfer. And there is a third group, the most constructive and powerful of the three, which is endeavouring to find just how much can be salvaged from the remains of this once magnificent structure, and put to use." [1]

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[1] Boyd H. Bode, *Fundamentals of Education*, New York, 1921, p. 145.

The existence of the three different views on the transfer of training is also indicated by Thorndike in his *Educational Psychology* (1921). He writes that, while "the notion of magic powers which, being trained by exercise of one sort to a high efficiency, held that efficiency whatever they might be exercised upon, has now disappeared from expert writings on psychology," yet "apparently some careless thinkers have rushed from the belief in totally general training to the belief that training is totally specialized" (in other words, that training is not transferable), and he says, "The real question is not, 'Does improvement of one function alter others?' but 'To what extent and how does it?'"[1]

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[1] W. Charters, *Curriculum Construction*, New York, 1923, pp. 23 and 24.

Starch expresses his approach to the problem in nearly the same words "The fundamental problem, however, is not, does training transfer? The task is more complex, and suggests rather the following three fundamental problems: (1) To what extent does training transfer? (2) To how closely or how distantly related functions does training transfer? and (3) How does the transfer take place?"[2] These last three questions may be taken as a fair summary of the present predominant current attitude towards the problem.

This sketch of the life-career of the transfer problem looks quite short—occupies just a few lines, but we must not forget that behind it there are centuries of time, hundreds of books, thousands of hot discussions, and hundreds of thousands of people trying to solve the puzzling problem And there are several quite interesting points in the historical development of the problem. First, it is remarkable that people for centuries could hold, contrary to facts, the belief in the wholesale transfer of improvement in one field to another, for instance, that memorization of Latin words would improve in the same degree the ability to remember names and faces But even more remarkable is the fact that in the twentieth century people can be found who consider training entirely "specific" or "untransferable." Starch says that "transference of training is one of the three or four most important perennial problems in the entire field of education."[3] One can without exaggeration say that, in a certain sense, it is the most important problem in education. Denying the existence of transfer of training means no less than denying the existence and possibility of training itself and, even more, of education as a whole. If one activity cannot influence any other activity, if all of them are mutually isolated, then obviously no progress, no improvement, no training, and no education are possible; because any new situation is completely new without any connexion with anything that happened before If any training is specific only, it does not exist at all, for what, after all, is "specific training," and what is "a specific ability"? Is the ability to read specific? No It is something general, because it is a sum of many different more "specific" abilities—for instance, the ability to read the word "Mamma," or "lion," or any other word Then maybe the ability to read any single word, for instance, the word "January," is a specific ability? Again no, because it is the sum of abilities to read combinations of letters like "Ja" and "nu" and "ary" Furthermore, even the ability to read the combination "nu" is not a specific ability, because it is the sum of abilities to read it at the beginning of a word and at the end, in print, in script, or typewritten, in black or in red, in large type or small, in a newspaper or in a book, when the reader is quiet and when he is excited, when he is all right and when he is sick, when he is ten years old and when he is twelve years old, etc, etc. Obviously the process of specification will go on *ad infinitum*, and even if in our imagination we reach the final "really specific" activity which cannot be specified any further, the activity will then be so unique, elementary, limited, and, so to speak, of no dimensions, that within it no training at all will be possible.

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[1] E. L. Thorndike, *Educational Psychology*, New York, 1921, vol. ii, pp. 364, 365, 358

[2] D. Starch, *Educational Psychology*, New York, 1921, p. 191

[3] *Op. cit.*, p. 191

But if it is so, how, again, could it possibly happen that, contrary to facts and to the testimony of reason, nearly all educators for many centuries believed that training is transferable in a wholesale way, one hundred per cent, and that later modern educators, as Charters says, in a very large proportion, have also denied completely, one hundred per cent, the transfer of training? The explanation lies mainly in the tremendous influence and inertia of static Logic, which determined the reasoning of the educators.

The first group of them quite correctly observed that training is transferable. To them probably the transferability aspect of training was especially obvious. At their time, under the influence of the scholastic schooling, they were more interested in generalizations on, and the relationship of facts than in facts themselves. In other words, the meaning of received facts, not facts themselves, was to them of primary interest, and therefore very probably their training was more transferable than our own, for, as Bode emphasizes, it is meanings that are at the bottom of the mechanisms of transfer.[1] Being firmly convinced that the statement, "Training is transferable," is true, and being not less firmly bound by the formula, "A is *either* B *or* non-B," they could not possibly admit that the statement, "Training is not transferable," can also be true, and therefore they believed that the transfer of training is wholesale, one hundred per cent.

Later, probably merely as a reaction to the previous attitude, or because of the general shift of the centre of interest to facts from their meanings, educators also quite correctly observed that training is not appreciably transferable in many cases, and expressed that in the statement, "Training is not transferable." Then, following the same general formula of Excluded Middle, they could not accept simultaneously the statement, "Training is transferable," and insisted on the wholesale, one hundred per cent denial of the transfer of training.

Habits of static reasoning are so firmly entrenched in the human mind that, to get rid of both extreme attitudes, the complete revolution in psychology was needed, and it took all the heavy guns of science to put the problem in the form of the question: "To what extent is training transferable?"

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[1] "Transfer of training means the extension or application of meanings to new problems or new situations" (*Fundamentals of Education*, p. 154).

Let us contrast this long and painful procedure with what would happen if the same problem were presented to dynamic reasoning. As soon as the statement, "Training is transferable," becomes an object of consideration, it is contrasted with the statement, "Training is not transferable." Then a continuum between them is postulated, the statement "Training is both transferable and not transferable" is formed, and inevitably the question, "To what degree is training transferable?" is propounded and directs further inquiry.

It is interesting to notice that the whole controversy is to a large extent due also to the discrepancy between our traditions of expression and the actual course of reasoning. One can hardly imagine that any sane person would really believe that training in painting will improve your singing ability, or that becoming an expert barber will qualify a man for understanding Higher Mathematics, or that any other "transfer" of the kind could take place—but actually "men wrote as if they believed substantially this," as Thorndike puts it.[1] Apparently they did so because they were forced to do so by the lack of proper logical language. Again, hardly any educator, even, in Thorndike's words, a "careless thinker," would actually mean that no training is transferable and that only the mythical "specific" abilities can be trained. If they insisted on that, it was only because they were handicapped by the inadequacy of the traditional tools of our reasoning.

Besides the general effect of the introduction of Dynamic Logic into education, it can very probably be of a certain value for a better understanding of the human mind generally and, more specifically, for the study of the growth of intelligence. When we begin to think of the evolution of human intelligence from birth to death, we soon realize that our knowledge of the process is rather one-sided. In the last decades much has been done for the study of intelligence in childhood and youth, so that we can form a fairly good picture of the process within the first 15–18 years Mental ages are nicely established; we operate with I.Q.'s, and have sufficient statistical data Almost everybody would agree, too, that at the other end of the curve of life we observe, in general, a gradual waning of the mental alertness, often terminated in very old age by something like an intellectual coma, the "second childhood"; but individual differences are so great here that we do not know when the decline actually begins, at 40 or 60, or later. But the region between these two ends, the middle of the curve, roughly between the ages of 20 and 40, is really a *terra incognita* from the point of view of the evolution of intelligence. Because our exact measurements end at the fourteenth to the eighteenth year (Binet-Stanford revision), one sometimes may hear statements like, "The average intelligence of a freshman and a professor is the same," or, "The average mental age of the majority of people is fourteen," which either is nonsense statistically or involves a hidden and unwarranted assumption that between the ages of fourteen and thirty-five there is no change in intelligence Setting aside speculations and inferences like these, and taking the results of measurements at their face-value, we must admit that we know very little about the matter.

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[1] *Op. cit.*, vol. ii, p. 417.

On the other hand, everyday experience and observation suggest that in the period between sixteen and thirty-five a certain process of the maturing of the mind surely takes place. Most of the achievements of the human intellect have been accomplished in that period or later. General experience in political life leads to the same conclusion, which is expressed in a fairly high age-qualification being required for responsible political offices. In this country, for instance, the minimum age for

Representatives is twenty-five, for Senators, thirty, and for the President, thirty-five.

But when we look for definite, tangible facts we can hardly find any intellectual activity in which it is possible to lay one's finger upon a clearly marked consistent general tendency in development, with probably one exception—the evolution of political ideas in men and woman between the ages of sixteen and thirty-five. It is safe to say that for that period, roughly speaking, the younger people are, the more they are inclined to political radicalism. In Russia, for instance (before the War and the Revolution), where political feeling was very keen in the Universities, the percentage of followers of revolutionary and socialistic parties was considerably higher among students than among men whose student days were over. The political career of the three strong men of Europe, Clemenceau, Lloyd George, and Mussolini, who all three started as radicals and later became quite conservative, is very typical, and, while we can find many cases like these, examples of the reverse evolution are very rare. Political parties are generally aware of the fact, and, as a rule, radicals insist on lowering the age-qualifications for the rights of voting and of holding office, while conservatives stand for high age-qualifications, both groups hoping to get more followers for their respective programmes.

But when the question is raised, why this is so, why the earlier age is more radical politically, explanations are not so easy to find and defend. The most common explanation, at least among the general public and sometimes even in scientific and semi-scientific circles, is that youth is usually more sensitive to new ideas, and therefore radicalism, advocating new and unaccustomed issues, naturally appeals more to young, fresh minds. In other words, the political conservatism of a riper age is explained as a result of its psychological conservatism. Sometimes the same idea is expressed a little more scientifically. The older human beings grow, it is often said, the more established and fixed become their habits, "associations," mind-sets, complexes, "patterns," synapses, and so on. Becoming less flexible, they naturally make people less capable of change and therefore more conservative.

This hypothesis, so plausible at first sight, is actually contrary to facts in many respects. First, if it is generally possible to express the evolution of our mental life in terms of conservatism and open-mindedness, it will hardly be a simple, consistent, and continuous increase of conservatism from childhood to senility. Everybody who has had the experience of telling stories even to very little children knows how many times they like to hear exactly the same story, and how conservative they are about the plot and the very wording. They strongly protest against the slightest change. Again, he who has worked in a school or camp knows how much children like all tradition, and how they insist on the same order and arrangement of their activities as they had before. In a boarding-school, the house-mother for several years used to announce the last instruction on the morning of the school Thanksgiving celebration, always starting with the words: "The great day has come." Once, when she omitted the words at the beginning of her customary speech, many boys were earnestly and sincerely disappointed, and said: "But why did she not say 'The great day has come' this year?" Any teacher knows that new ideas and new subjects do not find their way into boys' and girls' minds with lightning speed. In many cases, it is much harder to change habits in a boy of fourteen or fifteen than in a young man of twenty, and certainly it is easier to present a new point of view, a new situation, a new hypothesis, to a graduate student than to a Junior High School boy.

But even if, for the sake of argument, we admit that the young grasp new ideas more easily than adults, it will not explain political conservatism by psychological conservatism. Generally speaking, political radicalism is nothing particularly new. It is as old as civilization, and can be definitely traced back to the ancient world. At any definite historical moment it does not necessarily bring something that is new to the adults of the time. For instance, Marxian socialism passed through very few changes in the twenty-five years before the Great War, and what it fundamentally presented to the young at the beginning of the twentieth century was far from being something entirely new, of which they had never heard before, to their fathers.

But even if, again for the sake of argument, we admit that radical political ideas are something new, something to which adults cannot adjust themselves, it will be a proof not for the hypothesis but against it. For what is actually the fact for which we seek an explanation? It is, that if in a certain synchronous group of individuals at the age of eighteen or twenty, a certain number of people have radical political ideas, then later, in fifteen or twelve years, within the same group the number (and percentage) of people having radical ideas decreases. This means, in other words, that during this period of time a certain number of people *change* their political ideas. Obviously, if the fact which we are considering owes its very existence to changes in ideas, it cannot be explained by psychological conservatism. On the contrary, psychological conservatism, opposing any changes, would only tend to increase radicalism among grown-ups.

If the hypothesis of psychological conservatism does not explain the changes in the minds of the young, what other factors can be responsible for it? Hardly anybody will deny that in this age two definite tendencies are very prominent: increase in objective productiveness and in responsibility. Generally speaking, children and the young are economically and culturally (not morally or psychologically) parasites, in the sense that they get everything from others without repaying in any direct way. Only when they grow into adults do they begin to be directly productive and to contribute their share to the common civilization. On the other hand, by becoming economically self-supporting and acquiring new binding relationships in business, friendship, or family life, they acquire a much greater degree of responsibility. Both tendencies definitely indicate the increase in activities aiming at controlling our environment. From a contemplative, appreciative and, in a broad sense, artistic attitude towards the world, the young come to the work of controlling and reorganizing things and people all round. From the enjoyment of life they turn to management of it This growth of control means an emphasis on quantity versus quality In thinking it means the construction of continuous and quantitative scales, in other words, reasoning in terms of Dynamic Logic

If this is so, it will suggest an explanation of the fact that our measurements do not register changes in intelligence after the age of fourteen to sixteen The very fact that the tests are successful with children and the young shows that they measure predominantly qualitative intelligence Consequently, if the growth of intelligence later goes on along the lines of quantitative reasoning, it is only natural that the tests fail to reveal it. For the evaluation of ability to reason dynamically, tests of a different kind must be constructed, on the basis of the principles of Dynamic Logic First, the richness of the continua of an individual, their amount, must be measured, then their degree of continuity, and, third, the ability of the individual to use the continua for the evaluation and expression of particular cases. An idea of what the tests of this kind may be or, better, the idea of what may be a starting-point for constructing this kind of tests, may be obtained from the mental-physical activity scales described above in Chapter VI, p 162f. When a scale like that has already been established, the procedure of judging and listing the situations may be used as a test. The degree of correlation between the rating of an individual and the scale already established will serve as an index of the quantitative intelligence of the person in this field. When emphasis is laid on the ability to operate with quantitative indices, the scale, together with several situations within the same continuum, must be given to the measured subject, and he must evaluate the situation in terms of the scale. If the ability to construct continua or, in other words, the degree of continuity of continua is to be measured, then only two poles must be given, and the subject has to insert and arrange in the proper order as many situations as he can. To be sure, until proved by actual experiments, this suggestion remains a mere hypothesis, but in the light of the analysis of thought processes given above it looks very probable.

The next field where Dynamic Logic may be of value is that of instruction in Logic itself. The present position and prestige of Logic as a subject of instruction are not very enviable. In High Schools it is not taught at all. As one of the reasons for this, it may be said that Logic is too hard a subject for High School students, that is, above their comprehension. But this argument can hardly be defended, since High School students are considered able to understand laws of Physics, Chemistry, and Biology, and to study intelligently Government, Economics, Advanced Algebra, and Trigonometry. Obviously Logic is not intrinsically harder to understand than the other subjects mentioned, and certainly it can be presented in a form quite digestible for adolescent minds. The real reason probably is that no need for Logic in High Schools is actually felt. The situation is rather peculiar, especially now, when the watchword of education is "Less information, more thinking." Sometimes it looks as if almost the most important aim of education were considered to be the stimulation of thinking; and, at the same time, Logic, the science of effective thinking, is completely neglected in the education of all boys and girls who do not go beyond High School. Quite a recent book by Philip W. L. Cox on *Curriculum-adjustment in the Secondary School* (1925) presents a good illustration of the situation. It treats its subject in a very progressive way from a very broad point of view; it states as one of the principles of reconstruction of curriculum that "what must be taught in the secondary school should be determined first of all by the needs of community life" (community being defined as "not only the neighbourhood, and town, but also the state, the nation, and all humanity"[1]) and never mentions Logic as a subject which is actually taught or should be taught. Obviously Logic, as it is now, is not considered to be of much significance and use for humanity, and the worst of it is that Logic itself can hardly complain, being, probably, chiefly responsible for the situation.

In colleges, Logic is given a fair chance, it is taught extensively, and has behind it the tradition of being a part of the curriculum for centuries, since the Middle Ages. But the very fact that there is an old tradition behind it inclines one to suspect that the reason why we see Logic in college curricula now is mainly tradition. Further consideration of the matter strengthens these suspicions. In the environment of modern civilization cleverness and ability to solve the immediate problems of life are rewarded by success and social approval much more readily than other mental qualifications, such as a rich and harmonious emotional life or the gift for deep and sensitive appreciation. Under these conditions one might expect that youth would flock by thousands to study a science which promises to show how to reason correctly and avoid fallacies. But, as a matter of fact, Logic is by no means the most popular course in colleges The general consensus of opinion among students would hardly consider the study of Logic a definite requisite for successful competition, even in activities where thinking plays a predominant rôle. Nor are teachers, for their part, very enthusiastic and certain about the beneficial influence of the study of Logic. It is not a required subject in most colleges There is also a definite tendency to psychologize Logic, as it were, and to transform it into a kind of general Scientific Methodology. More and more, instead of regular textbooks in Logic, books like *How We Think* by Dewey and *An Introduction to Reflective Thinking* by Columbia Associates in Philosophy are recommended as a help in improving our reasoning. This view of the traditional Logic, on the part of the most disappointed and critical teachers of the subject, is well expressed by F. C. S. Schiller, himself a teacher of Logic. Says he, "In common with most teachers of Formal Logic, I had found it a very difficult subject to teach without loss of self-respect."[1] If we compare this statement with, for instance, Rabanus Maurus's glorification of Logic as the science of sciences, and the modern position of Logic with the place it held in Mediæval instruction, then the tremendous change in the status of Logic as an academic subject will be easily seen.

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[1] P. W. Cox, *Curriculum-adjustment in the Secondary School*, Philadelphia, 1925, p. 131

What are the reasons for such a remarkable downfall? The fundamental reason certainly may be suggested in the general change of direction in the development of our civilization and culture. In logico-psychological terms it can be briefly summed up as a transfer of the centre of interest from the relationship of statements to statements, on the one hand, to the relationship of facts to facts on the other hand. But this cannot be an exhaustive explanation. After all, what has happened is really only a transfer of the centre of interest, not a complete loss of interest in statements. Though probably we are now tired of words, books, hypotheses, and suppositions and do not like them, nevertheless both our civilization and our culture at present do depend on books and verbal statement to a very large degree, and as far as we can see they will depend on them at least for a very long time in future. Why, then, such a tremendous difference in our attitude to Logic?

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[1] *Formal Logic*, p. ix. His attitude towards the matter will be made even clearer by a few quotations from the index of the same book (see p. 230).

Very probably the explanation lies in the fact that we, as a race (or at least the part of the race which actually participates in the promotion of civilization), have to a considerable extent outgrown the need for formal instruction in Logic. The process is very similar to what has happened in the teaching of reading. In mediæval times there were few people who could read. They were rare exceptions. The process of acquiring the ability to read was very long and very unpleasant, and required tremendous effort and persistence. At present, because reading plays such an essential part in our everyday life, and is, so to speak, always about in the air, children in cultured families often learn to read by themselves, without being taught systematically. They do not make any conscious and tedious effort, but begin to read, easily and naturally, as they learn to walk or to talk. Probably the factor of social (and maybe even biological) heredity has produced the same effect on the process of acquiring correct ways of thinking as it has on that of learning to read. As far as the guidance of the old static Logic is concerned, we can probably acquire correct habits of thinking now without formal training, merely from the surrounding intellectual atmosphere, from books, discussion, press, and conversation. If this is so, then the old static Logic is dying out to a large extent quite naturally.

All this, to be sure, does not mean that all our reasoning is now perfect and free of error, or that we have no logical problems to puzzle us. As was shown in the first chapter, we probably face more difficulties and commit more fallacies in our reasoning to-day than ever before. All this is precisely because, having outgrown the old Logic, we have not yet constructed a new one, and therefore have neither real guidance nor definite standards. Under these conditions, if the coming new Dynamic Logic proves itself to be practical and helpful for modern reasoning, then, just because of its usefulness, it will inevitably refresh and enrich instruction in Logic. If, furthermore, it shows itself capable of growth and development, it will also help to restore Logic to its proper position among other academic subjects.

Besides being a systematic means of guiding our reasoning in the form of a special subject, the method of Dynamic Logic may be of considerable help in teaching generally, in all situations where the element of reasoning plays an important part. Since in any intelligently organized school the situations requiring thinking are supplied from the child's first steps in the school up to his graduation, the method of Dynamic Logic can be applied all the way through from kindergarten to college This does not mean that the principle of Dynamic Logic must be presented and explained to children and discussed with them in any formal or abstract way That would certainly be absurd What is meant here is that teachers should always guide children's thinking in such a way as to build up the habit of quantitative and dynamic reasoning

It has already been mentioned that human intelligence probably develops, up to the age of fourteen to sixteen, along the lines of qualitative reasoning, and later in the direction of quantitative thinking. The division is certainly not rigid, and must be understood in the spirit of continuity As a matter of fact, the forming of continua starts quite early, first, certainly, in a very crude form. Even such an elementary and childish statement as, "I *love* candy," or "I *hate* washing," can be gradually divested of its "one-hundred-percentism" and made more related with other situations, more continuous, and more relative. When a boy says about his school-mate, "Oh, he is so snappy," again it is good for him to be helped to realize what is "snappy" and what is "not snappy", in other words, what is the opposite to "snappy" When, in studying history or geography, a class has a discussion about "upper classes and lower classes," "civilized and uncivilized" countries, it is quite possible and very desirable to train students in the intelligent evaluation of the respect in which and the degree to which a certain particular nation is civilized or uncivilized, or a certain group of people is of the upper or lower classes. In other words, in discussions like these, students can learn the application of the principles of Partial Functioning of Concepts and of Quantitative Indices. Certainly the training in thinking along the lines of Dynamic Logic must be conducted very cautiously and balanced properly. Especially must one be on guard against emphasizing the Principle of Continuity before the habit of using the Principle of Polarity is fairly well established. Otherwise, reasoning may become chaotic and not discriminative.

Later, when the habits of dynamic reasoning are already fairly well formed, even the generalization of the method, if put into a simple and understandable form, can be presented without the risk of unnecessary theorizing A few definite rules how to organize inquiry and to construct required concepts and continua properly will by no means be superfluous and needless

With all the stress laid by modern education on thinking versus information, we do not know well how to train our students in efficient reasoning. We have not yet formed any definite rules and technique of the craftsmanship of thinking. It is true, we talk much of "stimulating" thinking, we have described and analysed the thought process generally and certain phases of reasoning particularly. Wishes and suggestions are expressed as to how ideal thinking ought to go on and what requirements it must satisfy. Also, the factors favouring successful thinking are listed. But we have not up to the present constructed workable canons and practical instructions how to operate with tools of our reasoning, how to manipulate with ideas and concepts We do not know what actually to do in any concrete given case, what to do in order to organize all the phases of the thought process in the most efficient way and to bring our reasoning closer to our ideal requirements

All this is very much like the knowledge of an intelligent visitor who has just passed through a good glass-factory.

He can describe the process of glass-manufacturing and different steps in it, he knows, too, what good glass should look like and what properties it possesses; but all this does not render him capable either of constructing a glass-factory or of taking part in the glass-making in any efficient way Even less can he teach others how to do it. The Mediæval intellectuals were much more fortunate in this respect than we. In Aristotle's Logic they had a real Organon, "instrument," or rather, the whole tool-box for their handicraft of thinking With the help of the formal or final "causes," the "categories," the Barbaras, Festinos, and Barocos of syllogism, the inversions, conversions, universals, particulars, and the rest, they could successfully do all the jobs of their trade in the manner required by the fashion of their time The intellectual fashion and needs have considerably changed since then, and have made the old organon to a great extent obsolete and out-of-date—like an abacus or an arbalest or a clepsydra. We have been forced to lay the organon aside, but without having devised anything so efficient and practical for our needs as the old Logic was for the schoolmen

Sometimes even the possibility of such general rules for thinking is flatly denied. It is said that thinking actually is a thinking about something particular and definite, that there is no such thing as thinking generally, apart from a concrete problem, and that therefore, obviously, no general rules for thinking can be devised. The argument is not strong, and is a result of misunderstanding, of confusing thinking in general, which is probably impossible, with generalization about thinking, which is quite possible. It is impossible, or at least absurd, educationally, to teach long division in general without concrete examples in actual numbers, but as a result of proper teaching a student acquires a general ability to do long division with all numbers, whether he saw them before or not. If well taught, he also acquires the knowledge of the general procedure, so that he can even describe it step by step without mentioning any definite numbers. The same holds true also for more complicated activities. It is impossible, for instance, to play music "generally" and not a certain particular piece of music, but, again as a result of instruction, a student learns how to play generally, in the sense that he acquires ability to play at sight, and quite well, music which he never heard before. At the same time he also learns certain general habits, attitudes and rules of execution which are quite general in the sense that they are applicable to any particular piece of music. If generalizations and rules are possible for mathematics, music, and anything else, there is no reason why it is impossible to make generalizations about reasoning The only question is, how to find real generalizations, in other words, workable generalizations which will make it easier to handle particular cases. In this respect, again, if the above considerations are correct, Dynamic Logic must be of considerable help.

CHAPTER VIII

COMPARISONS AND CONTRASTS

Absolute certainty is a privilege of uneducated minds—and fanatics. It is, for scientific folk, an unattainable ideal

—C. J. KEYSER

"Why could they, centuries ago, create cathedrals like that, and why cannot we now?"

"Because then they held convictions and now we entertain only opinions."

—TOURISTS VISITING AN ITALIAN CATHEDRAL

SINCE comparison and contrast are the foundation of any cognitive experience, the logical attitude presented above will probably be better understood when compared and contrasted with a few other points of view, either similar to it or helpful for the purpose in any other way. But, before we start to discuss any other logical position, we have to dispose of two necessary preliminaries. First, the characteristic features of the point of view presented in the discussion must be briefly recapitulated.

(1) As a starting-point, Dynamic Logic postulates continuity between any two units of thought, compared or contrasted. (This continuity is not mathematical but logical, and implies only that in our reasoning we can pass from one pole of a continuum to another.)

(2) Therefore the formula "A is simultaneously B and non-B" is accepted as a fundamental guiding-principle of reasoning.

(3) This means that qualitative contradiction (even so-called self-contradiction) cannot be considered as a basis for refuting any statement.

(4) This principle is counterbalanced by a persistent requirement of quantitative indices as quite indispensable to any statement claiming any meaning.

(5) Reasoning is considered, not in its aspect of an activity aiming at acquiring general and absolute Truth, but as an instrument for more efficient control of our environment. Consequently all ontological and epistemological problems are left out of consideration.

The second point to be considered here is terminology. For the sake of convenience and brevity, the logical attitude here presented will be referred to later as "Dynamic Logic." The term is not descriptive enough, and doubtless the term "Logic based on the Principle of Continuity" or, even better, "Quantitative Logic based on the Principle of Continuity" might better designate the typical features of the logical attitude, but they are too long and are, besides, prone even more than "Dynamic Logic" to be misunderstood without further explanation. With a sufficient explanation, however, the term "Dynamic Logic" will do as well as any other, and it possesses, at the same time, the advantage of being the shortest.

To start with, we have first to clear up a possible misunderstanding. It was said above that Dynamic Logic is an attempt to present a generalization of ways of reasoning which have come into use since the rebirth of Scientific Research in the fifteenth and sixteenth centuries, whereas classical static Logic represents the ways of thinking used in ancient and mediæval times. This statement itself must be taken in the spirit of continuity and relativity; otherwise it is misleading. It is not absolutely one hundred per cent true; it expresses only a general tendency and does not mean that, at present, all our thinking travels along the lines of Dynamic Logic, or that previous to the scientific renascence no one ever tried to reason in that way. As a matter of fact, we find one of the best examples of dynamic reasoning in Heraclitus' sayings—as far back in the past as the beginning of European philosophical thought, or, in other words, at the very birth of reflective thought made aware of itself.

Heraclitus is indeed a remarkable and extraordinary phenomenon in the history of human thought. Unfortunately we have only somewhat disconnected fragments of his writings and sayings Besides, he lived at a time when proper language had not been constructed to fit the discussion of abstract and general problems, and no definite tradition or habits of vigorous and systematic reasoning existed. Even so, no one who reads his sayings can help feeling the strong, determined personality of the philosopher, his keen and powerful intellect, and the remarkable consistency and comprehensiveness of his point of view

As a symbol and essence of all processes, both in the physical world and in the human soul, he takes "Fire," which always changes but nevertheless always remains the same "This order which is the same for all, no one of gods or men has made; but it was ever, is now, and ever shall be an ever-living Fire, with measures of it kindling and measures going out" (20).[1] The "Fire" certainly cannot be taken literally as a real fire, flame or combustion, as is obvious from other sayings. Heraclitus' Fire is more like cosmic dynamic spirit, life as opposed to mechanism in Bergsonian terminology, or as spirit versus matter "Fire is want and surfeit" (24). "It is the thunderbolt that steers the course of all things" (28), and, at the same time, "Wisdom is one thing. It is to know the thought by which all things are steered through all things" (19) The Fire is thus an absolutely necessary factor in all changes. "All things are exchanged for Fire, and Fire for all things, as wares for gold and gold for wares" (22), and eventually "Fire in its advance will judge and convict all things" (26). Only when transformed by Fire can a thing affect spirit: "If all things were turned to smoke, the nostrils would distinguish them" (37), but "souls smell in Hades" (38), even in Hades.

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[1] The numbers of the sayings are those given in J Burnet, *Early Greek Philosophy*, 3rd ed , London, 1930

The principle opposite to Fire, so-called "inertia" or "matter," is symbolized by water and moisture. "The dry soul is the wisest and best" (74), and "A man, when he gets drunk, is led by a beardless lad, tripping, knowing not where he steps, having his soul moist" (73). In the eternal redistribution of the *élan vital*, when Fire goes away its place is taken by water "Cold things become warm, and what is warm cools, what is wet dries and the parched is moistened" (39). "The transformations of Fire are, first of all, sea, and half of the sea is earth, half whirlwind" (21). Earth here represents even the higher degree of lack of Fire, the most static, solid, or, as it were, "material" state of affairs It is explained more definitely in another saying "For it is death to souls to become water and death to water to become earth But water comes from earth, and from water soul" (68).

If the "ever-living Fire" is accepted as a ruling principle of the universe, then certainly Heraclitus sees changes everywhere "The sun is new every day" (32) "You cannot step twice into the same rivers; for fresh waters are ever flowing in upon you" (41). Here one is surely more than tempted to quote the famous πάντα ῥεῖ —"everything flows"—were it not a whimsical joke of history that the best-known "saying" of Heraclitus was never said by him at all.

If everything is ceaselessly changing, and therefore nothing is completely self-identical, then it is quite natural that Heraclitus should so organize his reasoning that the formula "A is B and non-B" becomes the generalization of his thinking "And that is the same thing in us that is quick and dead, awake and asleep, young and old; the former are shifted and become the latter, and the latter in turn are shifted and become the former" (78). "Hesiod is most men's teacher. Men are sure he knew very many things, a man who did not know day or night! They are one "[1] (35) "The straight and the crooked path of the fuller's comb is one and the same" (50). "The way up and the way down is one and the same" (69) "In the circumference of a circle the beginning and the end are common" (70). "Good and ill are one" (57). "We step and do not step into the same rivers, we are and are not" (81).

Considering contradiction as something acceptable, Heraclitus also thinks that they are even necessary. From the epistemological, subjective point of view, "Men would not have known the name of justice if there were no injustice "[2] (60) From the ontological, objective point of view, "Men do not know how what is at variance agrees with itself It is an attunement of opposite tensions, like that of the bow and the lyre" (45). "Homer was wrong in saying, 'Would that strife might perish from among gods and men!' He did not see that he was praying for the destruction of the universe; for if his prayer was heard, all things would pass away" (43). And then, combining the objective and subjective points of view, he says: "Junctions are wholes and not wholes, that which agrees and that which differs, that which produces harmony and that which produces discord; from all you get one and from one you get all."[3] (59).

Having noticed all this, Heraclitus certainly could not overlook the importance of the relativity of things. He says: "The sea is purest and impurest water. Fish can drink it and it is good for them; to men it is undrinkable and destructive" (52). "Man is called a baby by God, even as a child by a man" (97). "The wisest man is an ape compared to God, just as the most beautiful ape is ugly compared to man" (98)

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[1] "Hesiod said one was the child of the other" (Burnet, *op cit.*, p 136)

[2] This saying is given in the wording of the first edition of *Early Greek Philosophy*, because it expresses the meaning of the saying more briefly and intelligibly

[3] Quoted from Aristotle, *De Mundo* v. 396, b, 20 (*The Works of Aristotle*, translated into English under the editorship of J A Smith and W. D. Ross, Oxford, 1914)

Even the importance of the quantitative aspect of phenomena was not missed by him Though not in a very definite way, yet he speaks of "measures of it [Fire—B. B. B] kindling and measures going out" (20) If one takes into consideration that in his conception the redistribution of Fire was a fundamental and the most general process, the statement acquires a tremendous universality and importance To emphasize the universality of the measure-principle, Heraclitus says that even "the sun will not overstep his measures, if he does the Erinyes, the handmaids of Justice, will find him out" (29).

All these sayings together constitute a coherent and comprehensive dynamic interpretation of the universe, and present a very fine example of dynamic reasoning It is true that it can be said that the philosophy of Heraclitus has nothing to do with dynamic Logic nor with any other Logic, because there is no Logic in it at all, that is, no generalization of reasoning, no rule or canon for it The statement is partly true, partly wrong. That no direct formulation of any logical principles can be found in Heraclitus' sayings is true, but it would be very surprising if they could be found. At the stage of development of philosophical thought which existed in Heraclitus' time there were practically no epistemological problems to puzzle thinkers The sophisticated distinctions between objective and subjective, noumenon and phenomenon, things-in-themselves and things as they appear to the senses, were not yet quite clear to them. They had no epistemology, nor did they need any It is true that in several of his sayings Heraclitus discusses the process of acquiring knowledge, but all of them are concerned with the degree of understanding things, the degree of organization of knowledge, while the very fact of understanding is taken for granted. The saying, "Eyes and ears are bad witnesses to men, if they have souls that understand not their language" (4) may seem, to us who know the problems of the theory of knowledge, like an attempt to discriminate between sense-data and *a priori* categories, but it may also be interpreted as a statement that stupid people cannot understand what they see or hear. This interpretation is backed by another saying, "The eyes are more exact witnesses than the ears" (15), which definitely shows that Heraclitus was concerned, not with the fundamental problem of the nature of the process of understanding, but with, as it were, the technique of it

Thus, without thinking much of the relationship between facts and statements of facts, and taking for granted that an exact "point-to-point" correspondence between them does exist, Heraclitus could not possibly think of laws regulating reasoning as different from laws regulating changes in things, and therefore he naturally expresses the relationship, not in terms of any abstract laws of thought, but as a fundamental principle of the universe. In other words, he expresses them not in logical but in ontological terms. Thus, instead of saying, "A is B and non-B at the same time," he takes the most general category in the realm of actual happenings — being — and the most general category in the realm of the evaluation of reality — "good and ill" — and proclaims, as general principles, "We step and do not step into the same rivers, we are and are not" (81), and "Good and ill are one" (57) Since both sayings together cover the whole possible extent of experience, they are equivalent in terms of Logic to the formula, "A is both B and non-B."

The same lack of criticism and willingness to take too much for granted is responsible for another and more serious shortcoming of Heraclitus' conception of the universe Paying so much attention to the phenomenon of change and motion, Heraclitus accepted it as a fact and did not try to analyse it further, nor to find out its nature or essence. The analysis would have led him inevitably to the concept of continuity and would have made his whole system more comprehensive and based on a firmer and better designed foundation. But in spite of shortcomings which were quite natural under the conditions, the philosophy of Heraclitus was an exceedingly remarkable attempt to apply dynamic reasoning to our interpretation of the universe.

Unfortunately, this glorious beginning was not followed by further success and was soon challenged by the exponents of the opposite point of view. It was Parmenides who championed against Heraclitus the cause of Static Logic.

While it was continuous change that impressed Heraclitus so much, the main issue of Parmenides' message was to assert the non-existence of change and the self-identity of everything. "One path only is left for us to speak of, namely that It is In this path are very many tokens that what is, is uncreated and indestructible; for it is complete, immovable, and without end" (8, 5).[1] "Wherefore all these things are but names which mortals have given, believing them to be true—coming into being and passing away, being and not being, change of place and alteration of bright colour" (8, 38).

Taking as his starting-point a position entirely opposite to Heraclitus' view-point, Parmenides constructed a system which in all its parts is a negation of the philosophy of Heraclitus. Contradiction and opposites are not only entirely unacceptable to him, but utterly absurd. He scorns "Undiscerning crowds, who hold that it is and is not the same and not the same, and all things travel in opposite directions" (6, 5). He expresses his point of view, not in form of concrete illustrations or particular phenomena taken as symbols, as Heraclitus does, but always in terms of "It," which in our modern philosophical language corresponds very closely to "Experience" as a whole. This "It" of Parmenides is the only reality; it is all-inclusive, absolutely independent of anything else and completely self-sufficient; consequently in the "real" reality not much room is left for any relativity or degree or "measure" Finally, quite consistently with all its other statements, the system culminates in the law of thought expressed in ontological terms in the words, "Therefore must it either be altogether or be not at all" (8, 11), which in logical terms may be best expressed as, "A is either B or non-B"—the fundamental formula of Static Logic

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[1] All quotations are from Burnet, *Early Greek Philosophy*, 3rd ed.

The logical significance of the speculations of Parmenides is even greater than of the philosophy of Heraclitus While strictly ontological in its form, *The Way of Truth* is mostly logical in its substance and content. Since Parmenides treats all problems in terms of his absolute "It," he obviously cannot obtain reasons and grounds for his statement from first-hand, immediate experience, which is always necessarily limited and relative. He not only neglects the world of phenomena, but even declares it all illusory and false. Therefore the only possible source of proof left is the logical coherence of the statement in question with other statements. The criterion of coherence or incoherence can only be a certain logical fundamental generalization or assumption; consequently all the proofs hinge round the assumed logical laws, and therefore all the speculations become not so much ontological statements as assertions of laws of thought.

More specifically, Parmenides established here a particular type of proof which has become one of the heaviest guns, if not the very heaviest gun, of Static Logic It is the indirect proof based, as it were, on circumstantial evidence. It runs like this. If a certain statement has to be proved true, then, as a first step, the opposite or contradictory statement is proved to be unacceptable. Then the law of Excluded Middle, "A is either B or non-B," comes in and, asserting that of two contradictory statements one must be true, takes care of the next step in the proof: If the opposite statement is wrong, the first statement is true. Since, actually, hardly any statement exists which is absolutely one hundred per cent acceptable, nearly any statement can be proved true by denying its opposite.

The consistency with which Parmenides applies this method of proof by questioning the opposite is shown by the fact that in all nine paragraphs of his *Way of Truth* this device is used.[1] In the first paragraph, defending his statement, "It is," he says: "For you cannot know what is not—that is impossible—nor utter it."

He ends the second paragraph with scornful denial of the idea "that the same thing and not the same thing is and not is."

Paragraph three: "It is. . . . For what kind of origin for it will you look for? In what way and from what source could it have drawn its increase? I shall not let you say nor think that it came from what is not, for it can neither be thought nor uttered, that is not."

Paragraph four: "Is it or is it not? Surely it is adjudged as it needs must be, that we are to set aside the one way as unthinkable and nameless (for it is not the true way) and that the other path is real and true," and so on.

Paragraph five: "Nor is it divisible, since it is all alike, and there is no more of it in one place than in another, to hinder it from holding together, nor less of it, but everything is full of what is."

Paragraph six: "Moreover, it is immovable . . . since coming into being and passing away have been driven afar, and true belief has cast them away."

Paragraph seven: "You cannot cut off what is anywhere from holding fast to what is anywhere; neither is it scattered abroad throughout the universe, nor does it come together."

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[1] The arrangement of the sections of *The Way of Truth* here adopted is that given in the first edition of Burnet's *Early Greek Philosophy* (London, 1892), following the *Historia Philosophiae Graecae* of H. Ritter and L. Preller. The only essential difference between this version and that of Diels', adopted by Burnet in the third edition of his book, is the order of the various sections of the poem. The Ritter and Preller version is chosen here because it allows one to see the character of Parmenides' logic more easily than Diels' arrangement does.

Paragraph eight: "It is the same thing that can be thought and for the sake of which the thought exists; for you cannot find thought without something that is, to which it is betrothed."

Paragraph nine: ". . . It is complete on every side, . . . for it cannot be greater or smaller in one place than in another."

It is really remarkable how abstract all the statements are, and how in every paragraph the arguments (and it is safe to say the chief arguments) are invariably, monotonously negative.

It is interesting to notice that "the greatest logician of all times," Aristotle, later definitely endorsed static logic against the dynamic reasoning of Heraclitus,[1] and by his authority made the static logic leading and predominant for centuries to follow.

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[1] The position of Aristotle is quite definitely and consistently static. He formulates the principle of Excluded Middle: "Nothing, however, appears to receive contraries simultaneously, as in the case of substance, for this indeed seems capable of contraries; yet no one is at the same time "sick" and "healthy," nor a thing "white" and "black" together, neither does anything else receive contraries at one and the same time" (*Organon, Categories*, vi. 12); and also, "It is, however, evident that it is impossible for true opinion to be contrary to true opinion, or true negation (to true negation); for contraries are what subsist about opposites, and about the same things the same may be truly asserted; but contraries cannot possibly be inherent in the same thing at one and the same time" (*Organon, On Interpretation*, xiv. 6). See also *Metaphysics*, iv. 3. He consistently applies it in his actual reasoning as a final criterion for accepting or rejecting dubious assertions, as, for instance, in the following statement: "From these, then, it is clearly impossible to opine and to know the same thing at the same time, for otherwise a man might have a notion, at one and the same time, that the same thing could and could not subsist otherwise, which is impossible" (*Organon, Posterior Analytics*, xxxiv. 4). And finally, on the foundation of the law of Excluded Middle he builds whole of his strictly qualitative Logic, with its nearly complete lack of quantitative discrimination and its great emphasis on absolute statements. So great was this emphasis that his crowning achievement and the core of the whole system, the syllogism, is invalid without at least one statement being universal, or in other words, one hundred per cent true.

The fact that, in the struggle between the Heraclitan dynamic logic and the static logic of Parmenides, the former was defeated, is due not so much to the strength of the static logic (which was not great at all) but to the weakness of the Heraclitan logic itself. In spite of its many advantages, dynamic reasoning has a very weak point—a tendency to become chaotic, unless reinforced either by objective quantitative scales or by an unusual intuitive sense of proportion on the part of thinkers. The last gift is not common and, while Heraclitus himself could successfully use dynamic reasoning by virtue of his obvious sense of proportion, his followers could not manage it at all satisfactorily, and their reasoning could easily become disorganized and confused. Plato in the *Theaetetus* vividly describes the followers of Heraclitus in the following words of Theodorus: "About these speculations of Heraclitus, which, as you say, are as old as Homer, or even older, the Ephesians themselves, who profess to know them, are downright mad, and you cannot talk with them on the subject For, in accordance with their textbooks, they are always in motion As for dwelling upon an argument or a question, and quietly asking and answering in turn, they can no more do so than they can fly , or, rather, the determination of these fellows not to have a particle of rest in them is more than the utmost powers of negation can express. If you ask any of them a question, he will produce, as from a quiver, sayings brief and dark, and shoot them at you, and if you enquire the reason of what he has said, you will be hit by some other new-fangled word, and will make no way with any of them, nor they with one another. Their great care is, not to allow of any settled principle either in their argument or in their minds, conceiving, as I imagine, that any such principle would be stationary ; for they are at war with the stationary, and do what they can to drive it out everywhere " (180).

This colourful description of the Heraclitans (which, by the way, may well fit some of our over-enthusiastic modern dynamists), while probably slightly exaggerated, gives a fair account of the general spirit of this sort of reasoning, and it is no wonder that Aristotle, in this dispute, took the part of the logic of Parmenides against that of Heraclitus

The next logical position we shall discuss here is the logic of Hegel. It was the general progress of the objective sciences and the ensuing change in general habits of thought, that made possible the appearance of Hegel as a leading figure in the European philosophy of the nineteenth century. Not many thinkers enjoyed such authority and influence over the minds of contemporary intellectuals as did Hegel. He was the greatest exponent of the dynamic attitude in the philosophy of the last century. On the foundation built by Kant, Fichte, and Schelling, he constructed the most comprehensive, all-embracing system of dynamic philosophy, in which his thorough, analytical mind tried by the most painstaking effort to relate and harmonize every detail of his great conception with other parts of the system and with the system as a whole To him everything in any single phenomenon around us, in the Universe as a whole (the Absolute), in the development of human mind, everything, everywhere, is in ceaseless change. Everything is a continuous becoming. Therefore, naturally, everything contradicts itself Hegel not only accepts contradiction, but regards his dialectic, that is, contradiction in action, as the fundamental principle and moving force of everything, and to him contradiction not only does exist but is definitely rational, and by no means something unacceptable and hopelessly puzzling. "Contradiction is the very moving principle of the world · and it is ridiculous to say that contradiction is unthinkable." [1] If contradiction is quite "thinkable," then the principle of Excluded Middle is wrong "Instead of speaking by the maxim of Excluded Middle (which is the maxim of abstract understanding) we should rather say 'Everything is opposite'"[1] The idea of opposition leads to the idea of Polarity: "The conception of Polarity, which is so dominant in physics, contains by implication the more correct definition of Opposition"[2] If we add that the greatest effort and probably the greatest achievement of Hegel was the reconstruction of Logic, and that practically the whole of Hegelianism is comprised in his *Logic*, everything else being only its further development, then it may look at first sight as though Hegel's speculative Logic were exactly the Logic to which the development of human reasoning led, and which could best fit modern thinking But now, after about one hundred years since the publication of his *Encyclopædia*, we can definitely see that Logic as a science guiding our reasoning was not at all affected by Hegel's writing Practical Logic is taught now as if Hegel never existed, and his fundamental logical assumptions did not show themselves capable of any development. Hegelianism as a whole is now mostly a historical issue, and already Karl Marx bitterly remarked that Hegel after his death was treated like "a dead dog"

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[1] *The Logic of Hegel*, translated by W. Wallace, Oxford, 1892, p 223

What are the reasons for such failure, after so glorious a rise? What are the reasons for the sterility of principles which looked so sound and promising? As Prof. Mackintosh has said, "No chain is stronger than its weakest link The chain of the Hegelian system is long; it goes three times round the Universe. It will be strange if there are no weak links in it."[3] And really, from the point of view of Dynamic Logic, there are many weak links in the chain. To begin with, strictly speaking, Hegel did not write a treatise on Logic, in any usual sense of the word. To be sure, he was not interested in Logic in the sense accepted in this discussion, that is, as thought-engineering, and was even rather sceptical about its usefulness. He said, "Any man, it is supposed, can think without Logic, as he can digest without studying physiology. If he have studied Logic, he thinks afterwards as he did before, perhaps more methodically but with little alteration."[1] In another place he is a little more generous and admits that, "The study of this formal logic undoubtedly has its uses. It sharpens the wits, as the phrase goes, and teaches us to collect our thoughts and to abstract."[2] But that utility does not justify the existence of Logic. Hegel denies Aristotle's formal logic, not because it is not practical enough, but in spite of its practical utility. "Its [Logic's—B B B] utility must then be estimated at another rate than exercise in thought for the sake of the exercise."[3] "The necessity of understanding Logic in a deeper sense than as the science of the mere form of thought is enforced by the interests of religion and politics, of law and morality"[4] "*Logic therefore coincides with Metaphysics, the science of things set and held in thoughts*"[5] The statement is put in italics by Hegel himself, and is really of great importance in understanding Hegel's position Logic as Logic was not at all interesting to him. To him it was a form of metaphysics And the form of metaphysics Hegel had constructed is of such a kind, that it can hardly be expected to be easily accepted by the modern mind. A quotation may give some idea of it: "The Absolute is the Essence. This is the same definition as the previous one that the Absolute is Being, in so far as Being likewise is simple self-relation But it is at the same time higher, because Essence is Being that has gone into itself. that is to say, the simple self-relation (in Being) is expressly put as negation of the negative, as immanent self-mediation."[6]

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[1] *Ibid.*

[2] *Ibid.*, p 221

[3] R. Mackintosh, *Hegel and Hegelianism*, Edinburgh, 1903, p 138

If, to Hegel, Logic actually is metaphysics, the discussion of Hegel's *Logic* could be closed here; but, while in Hegel's writings both of them are so closely melted together (as the quotation above also illustrates), nevertheless it is possible with a certain effort to divorce them, and, putting metaphysics aside, to consider Hegel's dialectic only from the logical point of view. Karl Marx and Friedrich Engels (as well as J. Dietzgen), for instance, did so, and used the dialectic with satisfaction, being far, far away from Hegel in their general philosophical outlook But, even so, there are many difficulties very hard to overcome. First, it is hardly possible to squeeze the metaphysical elements completely out of the dialectic without entirely destroying it If even the Absolute and all other ontological superstructures are removed and the dialectic is considered only as a methodological generalization helpful to a better understanding of the phenomena around us, even so, the certain ontological factor remains; without that dialectic ceases to be itself. The factor is the speculative spontaneity of endless development from inside itself, as emphasized by Hegel For him dialectic is really the moving principle of the world, which does not need for its operation any stimulus from outside, but works at its best in the purest form, when left entirely alone. "Everything that surrounds us may be viewed as an instance of Dialectic. . All things, we say—that is, the finite world, as such—are doomed, and, in saying so, we have a vision of Dialectic as the universal and irresistible power, before which nothing can stay, however secure and stable it may deem itself"[1] And again "Logic [and therefore Dialectic, as the most important part of it—B B B] is hard, because it has to deal, not with perceptions nor, like geometry, with abstract representations of the senses, but with pure abstractions; and because it demands a force and facility of withdrawing into pure thought, of keeping firm hold on it, and moving in such an element"[2]

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[1] *The Logic of Hegel* (Wallace), p 34

[2] *Ibid*, p 32

[3] *Ibid.*, p 45

[4] *Ibid*, p 40

[5] *Ibid*. p 34

[6] *Ibid*, p 207

The fact that Dialectic is thus completely independent of everything else is responsible also for its absolute character and *a priori* origin. Hegel considered his speculative Logic, not as an inductive generalization from the happenings in the Universe, but as an immanent primary normative principle only He was so sure of the absolute truth of his dialectic that on the basis of it he denied the scientific generalizations of Newton and Laplace By a certain *tour de force* the difficulty can be settled by considering the self-sufficiency of the dialectic as a mere statement of the fact that changes take place all the time, or by saying that, after all, if Hegel himself missed the importance of the factor of stimuli, the character and, as it were, technique of the work of the dialectic will not be changed if, as an addition to and correction of Hegel's scheme, stimuli are introduced as a factor in any actual case setting the dialectical principle to work, somewhat as a starter sets a motor working without affecting the motor's work itself

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[1] *Ibid.*, p 150.

[2] *Ibid.*, p 30

But this correction would hardly save the situation The next thing that is hard to accept is the very *modus operandi* of the dialectic, which is actually the sum and substance of the whole of Hegelianism It possesses three specific characteristics (1) from any starting-point anything in its dialectical movement, by an act of self-negation, jumps to its complete opposite , (2) from the other pole, again, by a second self-negation, it jumps to its first position , and (3) returning to its initial position, the thing is not what it was before, the first time , it is not identical with its previous self, but is something higher, as a synthesis of both previous positions These together constitute the famous Hegelian triad. None of the three points can be accepted as a universal principle, either on ontological or on logical grounds

First of all, Hegel insists on the aspect of the process which we tried to emphasize by the word "jumping," that is, on the suddenness of the transformation from a position to its opposite. The following rather long quotation states it definitely: "It is the same dynamic that lies at the root of every other natural process, and, as it were, forces nature out of itself. To illustrate the presence of Dialectic in the spiritual world, especially in the provinces of law and morality, we have only to recollect how general experience shows us the extreme of one state or action suddenly shifting into its opposite: a Dialectic which is recognized in many ways in common proverbs. Thus, *summum jus summa injuria:* which means that to drive an abstract right to its extremity is to do a wrong. In political life, as everyone knows, extreme anarchy and extreme despotism naturally lead to one another. . . . Everyone knows how the extremes of pain and pleasure pass into each other: the heart overflowing with joy seeks relief in tears, and the deepest melancholy will at times betray its presence by a smile"[1] Obviously it is impossible to accept that "sudden shifting" of one extreme to its opposite as the universal law of things. Most changes we can observe are of a rather gradual and continuous character, and even in the cases where changes are apparently sudden, as, for instance, the shift from despotism to anarchy mentioned by Hegel, actually the change is not a sudden jump from one extreme to another, but a rather accelerated last stage of gradual increase of popular opposition and protest on the one hand and of difficulties of the government in managing the people on the other.

From the cognitive and subjective point of view, the doctrine of changes from one extreme to another is also unacceptable and unintelligible. Indeed, if we think of two opposite poles, B and non-B, as ends of a line, and suppose a situation, A, to be near the pole B, then it is quite natural for A to reach the position near the pole non-B, if it continuously moves in the direction from B to non-B; but if A moves closer and closer to B, it is impossible for it to reach non-B, except by a wholly mysterious leap through the tremendous gap from B to non-B. In other words, Hegel's conception definitely violates the principle of continuity, and by diverging from the principle it inevitably introduces an element unintelligible, irrational, and mystical.

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[1] *Ibid.*, pp. 150–1.

The second point, by virtue of the same sudden change in direction of development, by means of the same mysterious self-negation, doubles the element of mysticism already introduced by the first point. But, in addition, it introduces the universal principle of the reversibility of phenomena Again it is obvious that there are many processes in the universe which run only in one direction. Not to mention such a broad generalization as the principle of entropy, it is enough to watch the changes in the human organism after, let us say, the age of thirty-five, or in the animal body after death, in order to see that changes may go in one direction, never coming back. The vigour and physical efficiency of the organism of thirty are never again repeated, and in the process of disintegration of the corpse the more complex molecules are changed into simpler ones, and there is no guarantee that the atoms which constitute them will again form more complex molecules of the same kind Even the illustration of the principle most popular among Hegelianists, the regeneration of organisms from eggs or seeds, actually only emphasizes that the principle is not universal at all, for the regeneration takes place only in one case, whereas in millions of other cases seeds and germs perish as the result of a definitely irreversible process. If but one half of all the offspring of a pair of fish or locusts were to survive, the whole globe would in a few years be covered with only that kind of animal Again, from the subjective and logical point of view, no observation will prove that all concepts regularly pass back to their opposites If we observe cases of oscillation of a certain unit of thought between two opposite poles, it does not necessarily take place for all units of thought, and if it does take place it happens, not as a result of an immanent tendency of the unit of thought, nor as a manifestation of self-unfolding from the inside, but as a result of interaction with other elements of experience.

The third principle, claiming that the synthesis, the return of a concept to itself, results always in a concept higher than the thesis and antithesis, would, if true, ensure an inevitable, automatic, and continuous progress in everything and would deny the possibility of processes repeating themselves or leading to results inferior to previous stages Any cyclic chemical process, the degeneration of the tissues of a living organism, or of a certain species, or of civilizations, or even of philosophies, proves that processes of this kind *do* exist.

The logical necessity of the spontaneous elevation of a unit of thought to a higher level only by the simple means of a double jump from one extreme position to another, is so unconvincing that even Hegel himself had to connect it with mysticism He writes "Speculative truth [the net result of the dialectical development—B B B), it may also be noted, means very much the same as what, in special connexion with religious experience and doctrines, used to be called Mysticism"[1] Though he goes on to explain that "the reason-world may be equally styled mystical—not, however, because thought cannot both reach and comprehend it, but merely because it lies beyond the compass of understanding,"[2] it is nevertheless true that in his triad there is much of something unintelligible not only for "understanding" but for human thought generally. And this irrational element in Hegel's dialectic is due mostly to the very distinct hiatus, the gaps between thesis, antithesis, and synthesis, and these gaps, in their turn, are due to the fact that Hegel, in the same way as Heraclitus, took motion as a fact without further analysis of it. He failed to see and appreciate duly the fact that the essence of motion is continuity, that without continuity nothing can be really dynamic. And therefore, while insisting so much on dynamism, emphasizing that everything is always in the state of becoming, Hegel nevertheless made in his triad a rather static combination of three separate units We have thesis-development in one direction, then a definite gap designated and concealed by the mysterious self-negation, then the development in the opposite direction, antithesis, then again a gap, the other self-negation and development in the previous direction, and finally, like a *deus ex machina*, a new thing, synthesis, something higher, broader, and deeper than anything previous, and also separated by a gap, even higher, broader, and deeper than before, which definitely disconnects it from anything else Between a real dynamic process and the triadic dialectic of Hegel there is the same relationship as between a moving picture of a race and a sequence of three slides shown one after another with a stereopticon: a snapshot of the start of the race, another of a moment in the middle of it, and the third of the finish of the same race.

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[1] *Op cit*, p 154.

[2] *Ibid*

To sum up, we may reduce what is acceptable in Hegel's dialectic to the following statements. everything is ever in a state of change, becoming, therefore nothing is again the same, any stage of a process is not something separate from previous stages but, in a certain sense, their result This is nearly the same as the point of view of Heraclitus, which is not surprising at all, for Hegel himself said that he accepted all the fundamental points of Heraclitus' philosophy [1]

And, accepting Heraclitean dynamism, Hegel naturally faces the same difficulties as Heraclitus. It is interesting that both Heraclitus and Hegel, the only definite and consistent exponents of extreme dynamism in philosophy up to the twentieth century, have acquired the reputation of being thinkers very hard to understand. Heraclitus, quite early, was called a "dark philosopher," and Hegel himself confessed before his followers: "One man has understood me, and even he has not." In the case of Hegel it may be partly explained by the elements of what may be called technical mysticism involved in his triad, but, after all, this mysticism was really only technical, and both in his philosophy as a whole and in his character Hegel was not at all a mystic, but a definite rationalist, probably too much of a rationalist, if we remember his famous, "What is rational is real and what is real is rational."[1] The real and fundamental reason of the "darkness" of both dynamic philosophers was pointed out already by Plato in his rather sarcastic remark: "The maintainers of the doctrine [that nothing is at rest—B. B. B.] have as yet no words in which to express themselves, and must get a new language. I know of no word that will suit them except perhaps 'nohow,' which is perfectly indefinite."[2] Laying aside the sarcasm, which everyone who has happened to have a discussion with the very extreme and orthodox dynamists will readily understand and excuse, we must say that Plato made his point excellently. Both Heraclitus and Hegel were hard to understand, because they had no proper means and tools by which to express themselves dynamically, no vehicle to carry on their new ways of reasoning. Our language is adapted satisfactorily to the expression of qualitative discriminations, but has no proper provision for quantitative expression. When dynamists abolish fast and rigid qualitative differences they can escape looseness, indefiniteness, and incommunicability only by means of certain tools for certain understandable quantitative discriminations and expressions. And neither Heraclitus nor Hegel was in possession of such language or technique. As individuals with a great sense of proportion, they could successfully go on in their reasoning without using definite quantitative characteristics, even to creating their very remarkable systems of ideas; but the systems, being only subjective and incommunicable, and therefore separated from the experience of others, had little social value and faded off upon the death of their creators. And here we come to one of the most fundamental differences between the Speculative

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[1] "There is no proposition of Heraclitus which I have not adopted in my Logic" (G. Hegel, *Lectures on the History of Philosophy*, London, 1892, p 279)

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[1] *Hegel's Philosophy of Right*, translated by S. W. Dyde, London, 1896, p. xxvii.

[2] *Theaetetus*, 183.

Logic of Hegel and the Dynamic Logic presented in this volume. In the form of the scales discussed above Dynamic Logic tries to construct, or at least to suggest, the possibility of constructing the objective tangible tools so much needed for consistent, quantitative expression.

Considering the state of science in general in Hegel's time, and of the sciences concerned with Mind especially, nobody can be surprised that Hegel did not introduce measurement into Logic. It would be a miracle if he had done so. In his time no one could even dream of measuring mental endowment or activities. The introduction by Dynamic Logic of measurements of units of thought has now been made possible only by the remarkable and really epoch-making achievements in mental measurements in the first decade of our century, the pioneers of which were Binet and Simon, and which have now grown into an independent branch of science with hundreds of people working in the field and hundreds of thousands of actual measurements made every year. Thus we see that the Dynamic Logic presented in this discussion—both in its general spirit and content (the problem was discussed in detail in Chapter V above) and in its technique—is a definite result and offspring of the tremendous scientific progress of the two last centuries.

The next question to be considered is the position of Dynamic Logic among the different modern logical movements or writings which discuss reasoning in general, and its relation to them.

From the point of view of Dynamic Logic and for the purpose of the discussion, all logical writing may be divided into six groups. The first group, which includes the majority of volumes entitled *Logic* and constitutes the great bulk of conventional "logical" thought, actually consists not of works in Logic, as a body of canons or principles of efficient reasoning, but of writings about Logic. The writings of this kind almost exclusively supply the material for conventional historical surveys of Logic, such as, for instance, the article on Logic in the

Encyclopædia Britannica. They attempt to discuss reasoning, its possibility, nature, and essence, in terms of any ontological and epistemological assumption the writer happens to believe in, and to interpret them from this particular metaphysical point of view. In other words, they are concerned not so much with reasoning itself as with the mutual relationship between reasoning and the different philosophical doctrines and beliefs. The typical representatives of this group of writings are the *Logics* of Bradley or Bosanquet or Croce[1] The relation of the Dynamic Logic to writings of this group is a kind of irrelation Neither in purpose nor in method have they much in common and therefore they remain quite apart

The second group includes Psychologies of Reasoning and Psychological Logics. They do from the psychological point of view what the writings of the first group do from the metaphysical view-point, they interpret Logic in psychological terms and describe its relation to other aspects of mental life—volitions, emotions, cognitive activities, other than reasoning, attitudes, habits, and the like They differ considerably in the proportion between their logical and psychological contents, some being Psychologies only, others, definitely Logics. Pillsbury's *Psychology of Reasoning*, Dewey's *How We Think*, Baldwin's *Genetic Logic* (Vol. I), and Wundt's *Logik*,[2] may well represent the group. How far psychology can be helpful to a better understanding of logical problems and to what extent Dynamic Logic actually has used the data of psychology was shown in detail above in Chapter V, so it is obvious that between this group of writings and Dynamic Logic there is a close co-operation But, on the other hand, one must not forget that the psychology of reasoning can never be a successful substitute for Logic, for the most important practical aspect of Logic, its normative character, is necessarily absent in psychology.

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[1] F Bradley, *The Principles of Logic*, London, 1922, B Bosanquet, *Logic*, Oxford, 1911, B Croce, *Logic as the Science of the Pure Concept*, London, 1917

[2] W Wundt, *Logik*, Stuttgart, 1893–5

The third group consists of writings on general scientific methodology like Jevons's *Principles of Science*, Pearson's *Grammar of Science*, the *Introduction into Reflective Thinking* by Columbia Associates in Philosophy, McCall's *How to Experiment in Education*, Wolf's *Essentials of Scientific Method*, and the like[1] They study how Logic can be used in the investigation of the phenomena of our world and for the better understanding of problems in their actual setting. In other words, they are primarily interested, not so much in the relationship of statements to statements, but in that of statements to facts, and are the outgrowth of the line of investigation put into a definite shape by J. S. Mill in the form of his "Inductive Logic" Any Logic proper, and consequently Dynamic Logic, apparently forms only a part of general scientific methodology, and therefore, while occasionally some very valuable suggestion may come to Logic from methodology, generally speaking, Logic is more helpful to Methodology than vice versa

There is one group of writings on general methodology which must be discussed separately This is the group of works which are concerned with the part which words play in reasoning Their main problem is the influence of words on thought, and especially the confusion and misunderstandings which this influence often introduces. This group of writings is represented by Ogden and Richards' *Meaning of Meaning*, Richards' *Principles of Literary Criticism*, Mortimer J Adler's *Dialectic*, and Mauthner's *Kritik der Sprache*

From the point of view of Dynamic Logic there are two points of special interest in this analysis of the linguistic aspect of reasoning The first is the emphasis on the fact that, besides the traditional function of "communication of ideas," language performs many other functions; for example, the function of exciting attitudes and emotions. When words are used to express statements, to represent or refer to certain facts or situations, it may be called the symbolic, scientific, "logical" use of words. When words are used to express or convey or stir up emotions, it may be called the emotive, "extralogical" use of words. Failure to discriminate in which of its aspects a word is used, inevitably leads to confusion and ambiguity.

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[1] W Jevons, *The Principles of Science*, London, 1905, K Pearson, *The Grammar of Science*, London, 1911, Columbia Associates in Philosophy, *An Introduction to Reflective Thinking*, New York, 1923, W A McCall, *How to Experiment in Education*, New York, 1923, A Wolf, *Essentials of Scientific Method*, London, 1925

The other point of interest is the emphasis on the symbolic nature of words. Very often words are treated as if they were minute but exact copies or *alter egos* of the facts and events for which they stand. In fact, words as a rule are but conventional symbols arbitrarily chosen to represent certain facts or happenings. They have no intrinsic connexion with the "referents" or facts to which they refer, and it is the process of reference or thought that brings together a word and its "referent." If this is forgotten, and words are seperated from the process of reference to which they owe their significance, two fallacies may result. If a word has lost its connexion with any actual referent (or never even had one), and functions independently and self-sufficiently, the result is verbal statements, verbal problems, verbal argument, and, generally, verbal reasoning. The magic of words, Plato's ideas, mediæval "entities," more modern "forces" and "faculties" may be taken as illustrations of this fallacy.

If a word happens to be chosen to represent two or more quite different referents, then failure to realize the fact and to indicate or distinguish, in any given case, which of the many possible referents is meant, results in ambiguity and misunderstandings. The words "beauty" or "meaning" illustrate this fallacy.

Since the study of linguistic symbolism deals with the relationship between words and facts, it is obviously a branch of general methodology; but, since it lays its main emphasis on words or statements, it is closely connected with Logic.

From a certain point of view, it may even be considered as an introduction to Logic, especially to Dynamic Logic, for what can be the use and value of statements which are not properly connected with and backed by facts?

But, on the other hand, it is easy to see that Dynamic Logic is a necessary propedeutics to this methodological symbolism. Methodological symbolism, like any other doctrine, can exist and function only as a set of interrelated and connected statements If so, to function properly it must obey the principles of Logic generally and of Dynamic Logic especially A few illustrations will make this clear. If we admit, in the spirit of static Logic, that words can be used either symbolically or emotively, an attempt to decide in any concrete case how a word has been used, will result in an endless and hopeless controversy, because actually any statement is always used both referentially and emotively. The driest scientific statement is not completely devoid of capacity to call forth certain attitudes or emotional evaluations, and the most emotional appeal must at least hint at some situation or event in order to be effective. Again, if we accept unconditionally, one hundred per cent, the traditional notion that each word represents quite a definite group of similar events and has a "definite definition," or if, on the contrary, we postulate, also one hundred per cent, that each word refers to many different referents, in both cases we are in a very embarrassing situation. The first position is obviously divorced from reality. The second, while generally true, is pragmatically sterile, converting language into a chaotic conglomerate of signs without definite meanings. Only by thinking of language as of a continuum of words, from pun-words and words of obviously double, triple, etc., meaning near one pole to the simplest and most definite symbols, like "this" or "two," near the other pole, can we get a flexible, definite, and workable conception of linguistic symbols. Each of them is both ambiguous and definite, but in a different degree. Only by arranging them in the continuum, determining the quantitative index of each, and treating them accordingly, can the problem of linguistic difficulties in reasoning be adequately solved.

Strictly speaking, the writings of all these three groups would be better called extra-logical, because they are primarily interested, not in the advancement of Logic as an organized technique of reasoning, not in the reorganization of different elements within Logic itself, but in the relationship between Logic and our Universe as a whole, or the phenomena of subjective experience, or the facts of the external objective world. Works presenting the classical Aristotelian Logic make the first group of writings logical in the strict sense.[1] This group includes a large number of volumes, beginning with the *Organon* itself, down to modern textbooks on Logic like, for instance, Davies's *Textbook of Logic*. Between these there is a long, centuries long, procession of books. They may differ considerably one from another in the number of details and niceties presented, in language, in appearance and age, in illustrations, in the amount of psychological interpretation introduced, but all of them are the same in the sense that they all teach the same Static Logic based on the law of Excluded Middle, with the same rules of definition, figures and modes of syllogism, obversion, conversion, and the like.

What is the relationship of Dynamic Logic to the classical Static Logic? Though they are in many respects quite different, nevertheless they are not at all entirely mutually exclusive, at least from the point of view of Dynamic Logic. Formally, it is quite obvious, if we consider Static Logic a particular part of Dynamic Logic dealing with propositions of the type corresponding to the following quantitative value of the fundamental law: A is both B (about one hundred per cent) and non-B (about 0 per cent). Dynamic Logic, being a more comprehensive, more exact, and more efficient tool of reasoning, is related to Static Logic as a more comprehensive method is, in general, to a less comprehensive one. For instance, the introduction of logarithms did not and never will stop the practice of direct calculation in simple cases of multiplication or division. The new modern conception of the electron considerably changed our general ideas on the structure of matter, but did not annihilate all chemical laws and generalizations, although it has modified some of them considerably. The same happened in physics with the introduction of the Einstein theory. The growth of our conception of number embracing all known numbers, transfinite ones included, shows how, whenever a new kind of number—fractions, negative, irrational, imaginary, and the like—was introduced, it did not destroy previously known numbers, but only modified our idea of them. The same situation arises when dynamic reasonings come to replace static logic. The practice elaborated by Static Logic need not to be thrown away, as a whole, but must be preserved in great part and must be extensively used in certain cases. But our general attitude to the practice must be changed and adapted to the principles of Dynamic Logic. In the cases where the new practice must take the place of Static Logic, a definite reconstruction of logical technique must be effected. What form the reconstruction may take is a problem for a special investigation, but its general character, as indicated above, will follow the line of introducing definite quantitative indices into all logical operations.

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[1] To be sure, it must always be understood that there are no rigid demarcation lines between the six groups of writings about reasoning. Many a work can be put into several divisions. For example, the very instructive and lucid little book by Keyser, *Thinking about Thinking* (New York, 1926), may be almost equally well classified as psychological, logical, methodological, and to a certain extent, even as epistemological and ontological.

The next group consists of writings which represent a definite and rather recent reaction against, and criticism of, the traditional Aristotelian Logic. The works most representative of the group are Schiller's *Formal Logic* and Alfred Sidgwick's *Distinction and Criticism of Beliefs*, *The*

Process of Argument, *The Use of Words in Reasoning*, and *Elementary Logic*.[1] The reason why these writings may be put in their own separate group is that they criticize and attack Aristotelian Logic, not because of its discrepancy with certain metaphysical, epistemological or psychological assumptions, but essentially from a purely logical and technical point of view. They do not judge Logic by any standards taken from outside or beyond it, but directly challenge its efficiency or, to use Aristotle's very expressive term, its "excellence," which does not seem to them to be very high. The centre of their attack is the formal aspect of Aristotelian Logic. Schiller calls his book *Formal Logic* and Sidgwick in *The Use of Words in Reasoning* gives to his summing-up chapter the unequivocal title "The Case against Formal Logic." To realize how severe and bitter is the attack on Formal Logic, it is sufficient only to read the following extract from the Index in Schiller's *Formal Logic*: "Formal Logic . . . its abstractions from Application (use), from Context, from Interest, from inferring, from judging, from real truth; from real meaning; from purpose; from responsibility; from time relations of thought; difficulties of; failure of, impossibility of its ideals, inconsistency of; injurious intellectually, to mankind, to religion, its uses as . . . a game, as examinable nonsense, as a pseudo-science, verbality of, leading to meaninglessness."[2] The entire criticism of *Formal Logic*, while as a whole quite effective, is primarily destructive and negative. Schiller ends his book with the following paragraph: "Our task is accomplished. We have struggled perseveringly to clear up the real nature of Formal Logic, its real motives and its actual effects. . . . To us, as logicians, it must suffice to have set our house in order and to have cleared the ground for a new Logic that will not disdain to reflect upon real thinking, nor confine itself to fictions and falsifications "[1]

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[1] A. Sidgwick, *Distinction and Criticism of Beliefs*, London, 1892; *The Process of Argument*, London, 1893; *The Use of Words in Reasoning*, London, 1901; *The Application of Logic*, London, 1910; *Elementary Logic*, Cambridge, 1914.

[2] *Op. cit.*, p. 416

A. Sidgwick's books are written in a very conciliatory spirit The spirit of the plea for tolerance and logical good-will is one of the main issues of his writings, and in their purpose they are primarily constructive. Roughly speaking, his treatment of the subject can be divided into three parts: (1) a general analysis of fundamental problems and difficulties involved in our discussions and reasoning; (2) a criticism of Formal Logic; and (3) suggestions on how to make our reasoning more efficient.

The first part is very interesting and instructive. As it seems to Sidgwick, one of the main difficulties in reasoning is the application of general statements to particular cases. A general rule may be quite correct, but it is often very hard to decide to which cases it may be applied, to which not. In this way our reasoning is very closely connected with and very much dependent on distinctions and classifications But since "Nature," as Sidgwick puts it, is continuous, all distinctions are, in a certain sense, artificial, unreal, and rough. Also, the establishing of immediate causes, on which our reasoning very much depends, is again extremely difficult, because we can establish causal relationships only between simple happenings, while actually everything is more or less complex Besides, a really immediate cause tends always to coincide with its effect. In technical language, the main and fundamental problem of reasoning in Sidgwick's opinion is, how to evade the use of the ambiguous Middle Term in Syllogism, which leads to the problem of proper definition of M or, practically, in most cases, to distinguishing between M in general and the M in the particular case, or the M from the point of view of the purpose of the statement concerned (M *simpliciter* and M *secundum quid*).

Says he: "The general result of our survey of reasoning and its risks of error is that all the most deceptive kinds of fallacy come under the notion of Ambiguous Middle."[1] All these difficulties are increased also by the fact that the words used to express our thinking constitute a very clumsy tool of reasoning. They do not represent our ideas adequately, and cannot express and follow the continuous growth of the concepts for which they stand

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[1] *Op cit.*, p. 409.

As a whole and in its details this analysis of the difficulties of our reasoning is very illuminative and suggestive, and strengthens the position of Dynamic Logic considerably.

The next part, the criticism of Formal Logic, is also very keen and effective The main charges against the traditional Logic are that it is clumsy and stiff-jointed, too abstract, too artificially simplified, that it often pretends to be infallible, and, in the attempt, becomes meaningless and useless, and that, above all, it is too formal in the sense that it separates the process of reasoning from its subject-matter, and is concerned only with general rules, while it does not show how to apply them efficiently to particular cases.

It would be rather a hard task to pick up and put together in a system all the different suggestions for the construction of a new and better Logic which can be found in Sidgwick's writings Fortunately for students of his logical position, in his last book, *Elementary Logic*, Sidgwick himself, in the last part of the book, gives a presentation of his point of view, which is of the nature of a summary of his previous works Here he contrasts the traditional formal Logic (which he spells with a capital L) and the new logic (spelled with a small l), and gives the main characteristics of the new logic Probably the best way to present his point of view is to use his own wording. About the main purpose and problem of logic he says " The central subject of logic is the risks of reasoning, so far as they admit of being recognized and understood."[2] ". . . The chief problem of modern thought—that of using general rules moderately and wisely instead of either accepting them as perfect guides or discarding them as worthless because they fall short of being strictly universal "[1] "We have *valuable* rules in plenty, but their value depends on their application not being taken too literally and stretched too far. The problem of right reasoning is that of taking our valuable rules with the requisite pinch of salt."[2] More definitely and in more technical language, the chief difficulty of modern reasoning is indicated as follows: "The general result of our survey of reasoning and its risks of error is that all the most deceptive kinds of fallacy come under the notion of Ambiguous Middle."[3] The situation of Ambiguous Middle is described as follows: "It is 'true' (in a sort of way) that S is M and also (in a sort of way) that M indicates P, and yet, because of a lack of correspondence between the two 'sorts of way,' the conclusion that S is P fails to be supported by these premises."[4]

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[1] *Elementary Logic*, p 241

[2] *Ibid*, p 170

The practical aspects of logic are described in the following way "The problem of teaching the new logic seems mainly to consist in making the student so familiar with this view of ambiguity that his whole conception of the use of language is affected by it. He has to think of 'facts' always as 'statements of facts,' statements which are necessarily descriptive and which necessarily take a risk and involve a possibility of well-concealed error "[5] "There is thus room for a good deal of instruction to be given in regard to the nature of definition as a remedy for a discovered ambiguity "[6] Along the line of definition: " . . Safety against error [of judgment as to what is a relevant, what is an irrelevant distinction—B. B. B.] depends on the extent and accuracy of our knowledge of (1) the individual difference itself, (2) the particular purpose in view, and (3) the relation between them "[7] The new logic makes the technical side of Logic simpler,

[1] Op cit, p 211
[2] Op cit, p 184
[3] Op cit, p 241
[4] Op cit, p 187
[5] Op cit, p 233
[6] Op cit, p 235
[7] Op. cit, p 240

discarding a "number of doctrines and technicalities" as lacking logical purpose. "In the first place, the intricacies of Mood and Figure are swept away; also (as we saw at pp. 77-84) the distinction between the categorical and the hypothetical syllogism and all the trivial minor distinctions belonging to the former; also (as we shall see in § 33) the distinction between inductive and deductive Logic. And of the numerous old distinctions between kinds of terms and between kinds of proposition, the few that are retained require to be seen from a different point of view, with a radically changed interpretation."[1] "As regards technicalities in general, the attitude required by the student of logic is the reverse of what it used to be. Our chief business now is not to 'learn how to name our tools,' but how to use them."[2]

For better understanding of the whole point of view, Sidgwick also recommends discussing and establishing connexions among different statements which together express his point of view, and as an example of such a group of statements he gives the following:

"'A' is A; till we know better.
'A' is not not-A; except when it happens to be so.
A is either 'B' or 'not-B'; or both or neither.
No statement with a meaning is indisputable.
Judgments are never simple.
A major premise has no Subject, but an antecedent and a consequent clause.
Predication claims the truth of analogy.
An assertion is the answer to a question with a meaning.
All questions are questions of words, even when they are questions of fact.
All importance is relative to some purpose.
Classes are made by Man, not by Nature.
Ambiguity is effective only in a middle term.
The contrast between Induction and Deduction has no logical importance.

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[1] *Op. cit.*, p. 169.

[2] *Op. cit.*, p. 170

There is no distinction except when there is also conjunction.
A mistake of fact always involves a misapplied distinction.
Definition of a species is of no use where the species needs subdivision.
All progress of knowledge involves further discrimination.
Definition to be effective in removing an ambiguity must be a postulate, and not a statement of fact.
Proof is never coercive." [1]

About the general spirit and method of logic as compared with Logic, Sidgwick writes, discussing Inductive Logic: "We no longer look for perfect rules and perfect models to which our argument shall conform. We no longer expect to get *conclusive* results, but only results guarded against such errors as our best existing knowledge and our utmost care may enable us to foresee and prevent. Though we still use our observation of Agreement and of Difference—there is obviously nothing else to use—we recognise that there is no advantage in formulating a Canon or a Method whose strict provisions we can never be sure we have reached. . . . On the view here taken, then, of the process of judging evidence, there are no canons which can tell us how to avoid error. Instead of them we have a review of the difficulties in the way of guarding our conclusions, whether main or subsidiary, against ambiguity of the middle term. . . No logic can seriously pretend to reveal those secrets of Nature which science is only gradually and laboriously discovering. Nor can it cure a dull mind of all its dullness, or make a careless temperament consistently careful, or remove by word of command those deep-seated habits and prejudices which are results of our training and character. Any pretensions, therefore, which we may be inclined to make for logic of providing security against error must be of humbler kind. The most it can do is to give us the same sort of insight that common sense and daily experience give us, but to give it in a more generalized way."[1] "The old assumption was that Logic could by itself decide whether an argument was sound or not, and that everyone must accept its verdict or be convicted of logical ignorance. The new logical method, by its own principles, is forced to be more modest in its claim. It recognizes that the only logical criticism of an argument consists in raising difficult questions which may lead us into numerous other difficulties before the parties concerned can agree to consider the original question settled. There is no coercion or finality anywhere in this method, but only an appeal of the same kind that all progressive science makes to us—namely, that before concluding that a piece of reasoning is unsound we should get to understand (to the best of our ability, as fallible men) how the error came to be taken for truth."[2] ". . . The new system will require from all parties concerned in its working more flexibility of mind and a larger distrust of the pretence of definiteness and certainty. . . . Not only are the new doctrines and technicalities less numerous, but our whole method admits of less verbal finality."[3]

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[1] *Op. cit.*, p. 241

When this logical position is approached from the point of view of Dynamic Logic, nothing can be said against its general tenor and purpose—to find ways "of using general rules moderately and wisely," and avoiding the fallacy of Ambiguous Middle. That general tendency is highly acceptable. But there are certain points in this logic which show tendencies quite opposite to the intent of Dynamic Logic. They are (1) the pronounced degree of distrust to canons and to "pretence of definiteness and certainty," (2) a certain lack of interest in logical technique, logical tools, and special differentiated logical devices, and (3) emphasis on insight or immediate judgment affected by the particular concrete circumstances of each given situation; in other words, emphasis on the subjective aspect of reasoning. In all three respects Dynamic Logic tends to take the opposite course: it firmly believes in the usefulness of canons, it tries to formulate them as definitely as possible, it undertakes, as one of its most important tasks, to make our reasoning as definite, exact, and precise as possible, it seeks to get more certainty at least about the degree of uncertainty of its operations; it sees the great possibilities in such technical devices as formulæ, scales, and indices; and, with the help of all these devices, it attempts to make our reasoning as objective, acceptable, convincing, and, in a certain sense, even coercive for everybody as possible. Probably the difference is more in degree and in emphasis than in quality and, as it were, in "essence," but practically it is important, because it enables Dynamic Logic to introduce quantitative treatment as its method, while Sidgwick's logic prefers a qualitative approach to problems.

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[1] *Op. cit.*, p. 192

[2] *Op. cit.*, pp. 215–216

[3] *Op. cit.*, p. 244

Another practical aspect of the difference is seen in the problem of the communicability of logic. Emphasis on subjective and qualitative poles brings with it a low degree of communicability. Sidgwick starts Chapter X of his *Elementary Logic* by saying: "The weak point of the new logic as contrasted with the old is the greater difficulty it presents to the examiner and perhaps, as yet, to the teacher."[1] In other words, he says that the difficulty arises when communication of the ideas is required for the purpose of instruction or of checking. The above-quoted (pp. 234-5) list of statements expressing the point of view of his logic is provided with a note: "There are few, if any, of these concise doctrines that cannot be misinterpreted, and therefore the problem in expanding them is to guard against this risk."[2] This note, indeed, is very appropriate and answers a real need, and in that way also indicates the low degree of the communicability of statements constructed in accordance with this logic. Another statement, "our whole method admits of less verbal finality,"[1] confirms the same fact. Dynamic Logic, on the contrary, sets before *itself* as one of its main problems the construction of devices and mechanisms needed for an easily understandable, unambiguous, and exact expression of our most important statements

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[1] *Op. cit.*, p. 223.

[2] *Op. cit.*, p. 241.

"Symbolic Logic" makes the sixth and last group of logical writings to be considered In many respects it is a complete opposite to the point of view of Sidgwick and Schiller. Sidgwick concludes his *Use of Words in Reasoning* with the following statement: "Logic will remain an almost useless study so long as we forget that it is in the subject-matter of reasoning, not in any abstract 'reasoning process,' that all effective error is concealed." C. I. Lewis, speaking from the point of view of Symbolic Logic, describes methods of that Logic as "valid for '*any*' subject-matter and independent of the nature of the subject-matter"[2] B. Russell declares quite definitely: "There is a certain lordliness which the logician should preserve; he must not condescend to derive arguments from the things he sees about him."[3] And truly it is almost impossible to imagine any Logic more formal and separated from subject-matter than Symbolic Logic in its modern development.

The main features of Symbolic Logic are adequately presented in the following definition given by Lewis: "Symbolic Logic is the development of the most general principles of rational procedure, in ideographic symbols, and in a form which exhibits the connexion of these principles one with another."[4] The most characteristic feature of Symbolic Logic is its consistent use of "ideographic symbols." As a matter of fact, a well-developed system of Symbolic Logic, after a few introductory remarks explaining the symbols used, can be presented only in terms of its shorthand, without a single word of any common language. What kind of symbols they are, a few illustrations will indicate. For instance, instead of saying, "at least one of the two propositions, p and q is true," they write "$p \vee q$"; "$p \supset q$" means "proposition p implies q" (B. Russell and Whitehead's notation); then "$g \supset . p \vee q$" means "g implies that at least either p or q is true" and "$p \circ q = - \sim (pq)$" (Lewis' notation) means "The statement that p and q are consistent is equivalent to the statement that it is not true that it is impossible that p and q both be true," etc.

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[1] A. Sidgwick, *Elementary Logic*, p 226

[2] C. I. Lewis, *A Survey of Symbolic Logic*, Berkeley (California), 1918, p 341

[3] Bertrand Russell, *Introduction to Mathematical Philosophy*, London, 1919, p 194

[4] *Op cit*, p. 1.

To be sure, strictly speaking, the ideographic symbols or peculiar shorthand used by Symbolic Logic is a device only for a special and better kind of presentation and fixation, and not of explanation, of our cognitive activities. Indeed, like all symbols, they do not say anything beyond the actual phenomena for which they stand. They represent certain logical units, do not introduce anything more than the units express, and have no meaning or significance beyond the meanings of the corresponding logical units. But, on the other hand, when applied consistently and vigorously, the ideographic method of representation brings in quite new possibilities for a much more comprehensive and inclusive correlation and reconstruction of logical units; and in this way it becomes more than a mere device of representation and grows into a new and extremely powerful, precise, and effective method of organizing our reasoning, in other words, it becomes a new method of Logic. The process which takes place here is very much like what happens in the transition from arithmetic to algebra. Strictly speaking, algebraic notation is merely a more convenient means of presenting certain cognitive processes which could go on even without algebraic notation, but when used extensively the algebraic notation grows into a special mathematical method, the complete efficiency of which one can easily realize when one compares any branch of modern calculus with the arithmetic of the Greeks or Romans

Ideographic notation is certainly extensively used by Symbolic Logic. Russell and Whitehead's *Principia Mathematica*,[1] for instance, is mostly pages and pages of queer-looking formulæ. And the results are truly remarkable. *Principia Mathematica* and Aristotle's *Organon* are indeed about as different as Greek arithmetic and modern calculus

The comparison of Symbolic Logic to calculus and even the mere appearance of the ideographic notation may suggest a considerable resemblance of Symbolic Logic and Mathematics Actually, the relationship between Symbolic Logic and Mathematics is much more fundamental and much closer than a mere resemblance Symbolic Logic combines characteristics of both Mathematics and Logic. It is a cross-breed between them or a fusion of both of them In more logical and exact terms, Symbolic Logic is a continuum, and a very thorough one, between Mathematics and Logic as poles As in any continuum, it is possible to approach the middle part of it either from one pole or from the other Starting from the Mathematics pole, we may consider Symbolic Logic as an outgrowth of Mathematics, starting from the Logic pole, we may interpret it as an outgrowth of Logic It is very interesting to notice that both these *a priori* possibilities were actually realized in the course of the development of Symbolic Logic.

Russell and Whitehead's *Principia Mathematica* represents the latter approach. the construction of Symbolic Logic by a consistent and ingenious development of a few very elementary logical assumptions. Considering the scale of the enterprise, its comprehensiveness, the simplicity and fewness of assumptions, the strictness of proofs, and the degree of co-ordination of all parts, the logical system of *Principia Mathematica* must be regarded as one of the most remarkable and monumental achievements of human genius. On the basis and by means of a very few primitive ideas assumed—such as implication, the relation of a term to the class of which it is a member, the notion of "such that," the notion of relation, etc.—without introducing later any new independent ideas, *Principia Mathematica* constructs not only the whole of Logic but, what looks nearly incredible, the whole of Mathematics. It is true that, before the properties of cardinal numbers are demonstrated, as Lewis remarks, some four hundred pages of prolegomena are required, but nevertheless when the idea of cardinal numbers is introduced it is expressed only in terms of the most elementary and purely logical assumptions There are three points in *Principia Mathematica* which have a special interest from point of view of Dynamic Logic. First—the Logic of *Principia* is definitely static in the sense that it is based on the law of Excluded Middle: "A cannot be B and non-B simultaneously" Both the law of Excluded Middle and the law of contradiction are explicitly stated in form of propositions 2·11 (p. 105) and 3·24 (p. 117). It is true that formally both principles do not seem to play any specially important part in the system. Neither of them is taken as a primitive proposition, and there are about thirty other propositions before the first of them. But in fact the law of Excluded Middle is, so to speak, a pre-elementary assumption of the whole system. The primitive postulates which are introduced at the very beginning unavoidably bring in the principle of Excluded Middle by the very manner in which they are stated. To introduce the idea of "p" and "$-p$" without "$\pm p$" is to assume tacitly that any "x" can be either p or non-p but not both at the same time. All other assumptions, as for instance, the idea of implication, "p implies or does not imply q," or the idea of a class and its member stated as "x is or is not a member of the class p"—all are possible only because of the unconditioned acceptance of the law of Excluded

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[1] A N Whitehead and B. Russell, *Principia Mathematica*, Cambridge, 1925

Middle, which is really the corner-stone and the very foundation of the whole system.

Secondly, *Principia Mathematica* is throughout thoroughly qualitative. Not only is the logical part proper exclusively qualitative, but, what is almost unbelievable, its mathematical part is so constructed that Mathematics itself is presented in terms exclusively qualitative. Instead of a conventional understanding of Mathematics as a science whose subject-matter is magnitudes and numbers, it is here considered, probably for the first time in the history of humanity, as a complex of different relations which are capable of being completely expressed in exclusively qualitative terms.

Thirdly, the logic of *Principia Mathematica* is concerned with particular cases only as already actually or potentially related to the previously established generalizations and groups. Any item is considered either as a member of a certain class, or as already " implied by " or " implying " something, or as equivalent to something, and so on. All cognitive processes connected with reaching the decision, whether " *p* " is (or may be) a member of a class A or it is not, or whether " *q* " may or may not imply " *p* "; in other words, all cognitive processes involving the identification of a particular case, are left out of consideration entirely. It is obvious, therefore, that in the whole system there is no room for any " border-line " cases or cases partially within a class or partially outside it.

The three characteristics—the assumption of the law of Excluded Middle as the foundation, the exclusive qualitativeness, and the emphasis on general rules rather than on ways of applying them to particular cases—are very closely related one to another. It is even fair to say that they are only three different aspects of the same type of cognitive activities. This close connexion of the three characteristics may be seen even in the traditional Static Logic, but not very clearly. The logic of *Principia Mathematica*, with its mathematically precise form of expression, shows it much more definitely. But in the other system of Symbolic Logic—the Boole-Schroeder Calculus of Logic—it is made quite explicit and obvious.

It is worth while to notice that, though they have two quite different starting-points and therefore two different methods, the two systems, the Boole-Schroeder Algebra and *Principia Mathematica*, reach a similar conclusion and construct very similar systems. The similarity is so great that Lewis says definitely: ". . . So far as the logic which we have expounded goes, the two methods give roughly identical results "[1] That, to be sure, must naturally be expected when the continuity between poles is established as well as it is in this case where Mathematics and Logic both are transformed and combined into one continuum of Symbolic Logic

As mentioned above, the Boole-Schroeder Algebra of Logic approaches the problem from the mathematical point of view and on the basis of mathematical assumptions Its central idea is that it considers Logic as a special kind of Algebra, where all variables used have only two possible values, 0 and 1 If we accept this limitation and consistently follow it, all algebraic propositions and operations hold good for Logic, understanding by the term "Logic" the traditional Static Logic. In its logical aspect, the assumption means that any unit of thought may either possess certain characteristic completely, "1" or, in other words, one hundred per cent, or possess it in the zero amount, in other words, possess it not at all. From this point of view the assumption is an assertion of the exclusively qualitative character of the Logic of the system. On the other hand, the assumption leads immediately to, or, we may even say, expresses itself best in the form of the equation $x^2 = x$, when the equation is considered to be universally true. The logical significance of the equation is well expressed by Boole himself in his epoch-making *Laws of Thought*[2] as follows:

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[1] C Lewis, *A Survey of Symbolic Logic*, p 190

[2] George Boole, *Collected Logical Works*, Chicago, The Open Court Publishing Company, 1916.

"That axiom of metaphysicians which is termed the principle of contradiction, and which affirms that it is impossible for any being to possess a quality and at the same time not to possess it, is a consequence of the fundamental law of thought whose expression is $x^2 = x$." [1] Then he writes the equation in the form

$$x^2 - x = 0 \text{ and } x(1 - x) = 0 \ . \ . \ . \qquad (1)$$

and, giving "to the symbol x the particular interpretation of men," illustrates its logical meaning by the statement that the equation (1) thus expresses "the principle, *that a class whose members are at the same time men and not men does not exist.* In other words, that *it is impossible for the same individual to be at the same time a man and not a man.*" [2] Thus we see that the mathematical presentation shows very clearly that there is a close intrinsic and fundamental relationship between the law of Excluded Middle and the exclusively qualitative character of Static Logic, because both the principles are actually expressed here by the same equation $x^2 = x$.

It is interesting to see how the mathematical analysis of this equation leads Boole to some very suggestive deductions concerning the general character of static reasoning. Says he: "I desire to direct attention also to the circumstance that the equation (1) in which that fundamental law of thought is expressed is an equation of the second degree. Without speculating at all in this chapter upon the question, whether that circumstance is necessary in its own nature, we may venture to assert that if it had not existed, the whole procedure of the understanding would have been different from what it is. Thus it is a consequence of the fact that the fundamental equation of thought is of the second degree, that we perform the operations of analysis and classification, by division into pairs of opposites, or, as it is technically said, by dichotomy." [3]

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[1] *Op. cit.*, p. 54; original 1854 edition, p. 49.

[2] *Op. cit.*, p. 54; original edition, p. 49.

[3] *Op. cit.*, p. 55; original edition, p. 50.

To be sure, it is quite possible—and probably truer—to say that not the dichotomy, etc., is a consequence of the properties of the fundamental equation of thought, but, on the contrary, the properties of the equation are a consequence of the acceptance of the law of Excluded Middle and of the principle of dichotomy as the fundamental canon of our reasoning. But the question as to which is effect and which is cause, is of small importance here, the significant fact being the close relationship of the factors concerned.

Summing up the different logical attitudes discussed above, we see that, putting aside the metaphysical and psychological interpretations of Logic, there can be found at the dawn of self-conscious human thought, as well as at the present time, two opposite types of reasoning and logical theory.

The first, illustrated by Parmenides, Aristotle, and *Principia Mathematica*, is based on the law of Excluded Middle. It is static, absolutistic, exclusively qualitative in connotation, and formal, and lays emphasis on general rules rather than on particular cases or, in other words, on secondary rather than primary cognitive experiences. Its advantages are that it is definite, easily expressed in verbal or ideographic symbols, and therefore easily communicable; that it satisfies the passive, contemplative aspect of the human mind and gives certain guidance in managing simple and clearly-outlined problems.

Its disadvantages are that it is considerably divorced from the stream of events in the ever-changing reality, that its general rules are very hard and often even impossible of application to particular cases, and that, therefore, it is helpless before many most important problems of the border-line-case-type and dealing with processes of a high rate of change.

The second type of reasoning, illustrated by Heraclitus, Hegel, and Sidgwick, is based on the law of Included Middle—A is simultaneously B and non-B It is dynamic and relativistic, and lays more emphasis on particular cases and primary cognitive experiences than on general rules and secondary cognitive experiences Its main advantages are that it is remarkably in tune with the dynamic aspect of the Universe, that it therefore satisfies the tendency of our mind to produce changes in our environment and to control it, and, last but not least, that it has great possibilities for introducing quantitative evaluation into our reasoning

Its chief disadvantage is that the possibilities just mentioned have never been realized socially. If the Logic of Excluded Middle has only two quantitative indices, 0 and 1, the Logic of Included Middle, in the form in which it has existed up till now, having abandoned the narrowing limits, has introduced nothing in their place, and has therefore become even less quantitative than Static Logic As a consequence of this come indefiniteness, distrust of general laws and formal rules, and incommunicability. All this accounts for the fact that, while individual thinkers possessing a keen sense of quantitative judgment and of proportion have individually used the Logic of Included Middle as tools for reasoning with remarkable success, socially the Logic has never been constructive enough and has not yet realized its great possibilities. Thus far it has been used mostly in its negative capacity as a counter-check, as a protest against the clumsiness and inefficiency of Static Logic—in this latter capacity as political parties are sometimes supported, not so much for their merits as because of the mistakes and inefficiency of their rivals.

This brief summary indicates the position of the logical attitude presented in the previous chapters. It takes the two types of reasoning, not as separate and independent entities, but rather as two poles of one continuum, and it tries to construct a system which, to a certain degree, unites the positive aspects of both and eliminates their defects As a foundation, the principle of Included Middle is accepted, and this insures the dynamic spirit of the whole enterprise. But it is not taken as a mere general principle, rather chaotic in its implications; by a consistent application of the principles of Continuity and Relativity, an attempt is made to develop it into a set of general formal canons To make the general principles more applicable to individual cases and to make the whole system more definite and communicable, the main defect of both types of Logic mentioned above, namely, the lack of quantitative evaluation, is eliminated by introducing the requirement of quantitative indices As one possible way of realizing this requirement, the quantitative scales are suggested.

The Dynamic Logic presented here has as its starting-point the postulate of Included Middle, which has often shown a tendency to grow into logical points of view, rather informal, or even antagonistic to any formal principles. But it is interesting to notice that the introduction of the quantitative evaluation reduces the tendency so much that even the quite formal development by methods of Symbolic Logic looks fairly probable. If Boole's Algebra, where the value of variables is postulated to be either 0 or 1, represents a mathematical treatment of Static Logic, it is quite plausible to expect that Algebra, where the value of variables is postulated to be everything between 0 and 1 as limits, if such an Algebra shows itself capable of growth, may develop into a Symbolic Dynamic Logic

As may be seen from the above presentation, the synthesis of the Dynamic Logic based on the Principle of Continuity was guided by two ideas the definite inefficiency of the classical Static Logic and the vision of the coming new Logic—the Logic both practical and comprehensive, definite without being dogmatic, precise without being pedantic, and flexible without being chaotic. To what degree and by what means this ideal of Logic may be realized the Future will show, but every step in this direction answers a real need.

CHAPTER IX

IMPLICATIONS OF DYNAMIC LOGIC

Render therefore unto Caesar the things which be Caesar's, and unto God the things which be God's.—St Luke.

In conclusion, several bearings of Dynamic Logic on certain problems outside of Logic proper must be mentioned.

First let us take an inference from Dynamic Logic which should never be drawn, though there is probably a strong temptation to do so. From the emphasis frequently laid by Dynamic Logic on the controlling aspect of experience versus contemplation and on relativity versus absolutism, one may draw the conclusion that acceptance of Dynamic Logic means generally an exclusion of the contemplative and appreciative elements of experience and a denial of absolute values. It is not at all so. If it were possible to choose between a world of experiences, completely controlling, and a universe of pure appreciation, the present writer himself, for instance, would definitely choose the latter. He ventures to say that he would be backed in this choice by a great majority, because even people who enjoy controlling activities tremendously, after all, *enjoy* them. This means that people perform them for the satisfaction which they bring; in other words, for the appreciative and passive aspect of them. But, unfortunately or otherwise, the nature of the world of our experiences is, in fact, of such a kind that it is impossible to find any activity absolutely passive or absolutely controlling.

Furthermore, even a persistent selection of extremely controlling or extremely appreciative experiences, although actually possible, in the long run, is detrimental both socially and individually. Thus, because of their indulgence in the appreciative aspect of experience and their neglect of the controlling counterpart of it, the Russian intellectuals were cast by the cataclysm of the Revolution from the social position which they ought to have into the depths of indescribable suffering and even into danger of physical destruction. On the other hand, modern Western industrial civilization, with its over-emphasis on control and appalling neglect of contemplation, is very probably doomed. If no new factors enter and change the present trend of development, Western humanity either will be completely dehumanized or will perish in an all-destroying war. Individually, an exclusive emphasis on efficiency would make men into sterile and unproductive Robots,[1] while a one-sided cult of appreciation would produce the ugly and unsound greenhouse æstheticism, whose victims can be found in any large "Bohemian" centre.

The impossibility of excluding the contemplative aspects of experience and the danger of extremism in this respect also give the answer to the question of the exclusion of absolute values. As far as we are interested in control, we must be relativists. As far as the emphasis is laid on contemplation and appreciation, the absolute values are the ones which particularly satisfy us. Intensive adoration in Religion, admiration in Art, meditation in Contemplation, and devotion in Love and Friendship are experienced and can be expressed only in terms of absolute values, incomparable and unique. The need for absolute values is directly proportional to satisfaction by the experience and to lack of desire to change or control the situation.

The next point is philosophical. It is impossible to overestimate the significance of Kant's Copernican revolution. Before it, the things around us were considered as something primary, "really real," and our knowledge of things was thought to be derived from them Kant pointed out that, on the contrary, in fact the properties of our intellect determine the world we live in. In other words, he proclaimed that not ontology is a key to epistemology, but vice versa, epistemology conditions ontology. If this is so, if epistemology is more primary than ontology, obviously in our endeavours to understand the nature of the universe we have to start with an investigation of our cognitive faculties. Accordingly, Kant performs his keen analysis and critique of our reason. But in this form the course of the philosophical Copernican revolution is not complete. Epistemology is not a completely independent term, nor the most primary term, in the process of a philosophical interpretation of experience So far as it is presented or experienced in terms of statements, it is conditioned by Logic, which guides the construction and evaluation of the statements. Thus the analysis and critique must be extended farther down, to the foundation of the whole philosophical inquiry—into Logic itself. To be sure, if it is assumed that there can only be one Logic, then Logic is accepted as something unique, independent of anything else, and completely primary. In this case, a critical analysis of Logic is not especially necessary, because it can hardly be expected to influence epistemology and ontology to any considerable degree Probably it was so in Kant's own case, for it looks as if he considered Logic definitely bound by the Law of Contradiction But if the considerations presented above are correct, and we have to choose between two Logics—the Logic of Excluded Middle and the Logic of Included Middle—then the situation is entirely different. Any epistemology and ontology, then, are definitely determined by Logic. That it is really so, can be seen in the case of Kant. His antinomies, which play quite an important part in his conceptions of the world of things-in-themselves and of the world of our experience, are puzzling sphinxes only from the point of view of Static Logic. From the point of view of Dynamic Logic they do not need any metaphysical by-structures to be acceptable, and therefore do not necessitate the assumption of any transcendental entities.

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[1] K. Capek, *R. U. R. (Rossum's Universal Robots)*, Garden City, New York, 1923.

An even better illustration is supplied by Bradley's *Appearance and Reality*. The whole of his argument and search for reality is an ontological interpretation of Static Logic generally and of the Law of Excluded Middle particularly. He takes in turn the most significant aspects of our experience—primary and secondary qualities, things and their qualities, relations and qualities, space and time, motion and change, cause and effect, activity and passivity, self, and the like—and points out that all the categories involve "contradictions," "inconsistency," "self-discrepancy," and so on. Then, accepting as a supreme criterion of reality an absence of contradiction—"Ultimate reality is such that it does not contradict itself, here is an absolute criterion"[1] he proclaims that all the phenomena enumerated above are not reality but an appearance

It is easy to see that the choice of this criterion of ultimate reality is equivalent to acceptance of Static Logic as the only Logic possible. Also it is obvious that Static Logic is the main if not the only factor determining the ontological views of Bradley[2]

Dynamic Logic may also make some contribution to the general methodology of the sciences dealing with the behaviour of human beings, and especially with so-called inner experience Philosophy, Ethics, Æsthetics, Education, Psychology, Sociology in part, and the like, form this group of sciences, which might be called humanistic or mental sciences. Their methodology has not yet reached a satisfactory level of development.

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[1] F Bradley, *Appearance and Reality*, London, 1893, p 136

[2] It goes without saying that here we are concerned with the logical structure of Bradley's argument, not with the general truth or falsity of his constructive conclusions Also the question as to whether the logical narrowness and dogmatism of his argument actually invalidates his position is left entirely open It is only interesting to notice that Bradley's final conclusions sound very much like a piece of Dynamic Reasoning, and can hardly be easily accepted on the basis of strict Static Logic.

Of all sciences, Mathematics was fortunate in constructing the first satisfactory method. To be sure, in the different branches of Mathematics, new devices and special methods have been introduced all along, but the remarkably satisfactory general method of Mathematics was formed almost from its very beginning. The high degree of perfection of the method is best expressed in the definiteness and communicability both of the problems introduced and of the results reached. The group of sciences such as Chemistry, Biology, Geology, which comprises Natural Science, was the next to build a fairly efficient general method. Less efficient is the method of the social sciences, such as Economics or Sociology, but in the worst position of all are the disciplines, mentioned above, which form a group of mental sciences The inefficiency of their method is expressed especially clearly in the fact that too many of their propositions are merely matters of opinion, and not generally accepted theories. The attempt to make a wholesale transfer of the method of Natural Science into the disciplines of this group can hardly be of great help Behaviourism is trying it now in Psychology, and is creating a new science, which is rather interesting in itself and may be of practical importance in the future, but can hardly be a successful substitute for Psychology. The subject-matter and problems of the mental sciences are of their own kind, quite specific, and compelled therefore to work out their own method. Since the greatest handicaps in this field are the difficulty of applying general propositions to individual cases and the lack of quantitative evaluations, Dynamic Logic, which attacks both problems, promises to be of considerable help here

With the help of Dynamic Logic it is becoming possible also to begin an investigation of the individual characteristics typical of the reasoning of different writers and thinkers. In other words, it is possible to start a new study of human mind which can be called Logic-analysis. The traditional Logic, with all its technicalities, scarcely provided any practical means for this kind of investigation. Obviously it would be rather a disagreeable undertaking to search in the works of a reputable writer for mistakes against the rules of traditional Logic. Probably a few *petitiones principii* or *ignorationes elenchi* would be found, occasionally even undistributed or grossly ambiguous middles might be discovered, but all this would not throw much light on the individual logical style of the thinker, any more than cataloguing violations of the rules of elementary grammar would give an idea of the literary style of a novelist. Dynamic Logic offers quite different possibilities. To what degree the reasoning of the writer is dynamic and to what degree static, what are his favourite continua, how rich and continuous they are, how skilful he is in quantitative evaluation and to what extent he uses it, all this can be analysed by means of Dynamic Logic. When its quantitative method is applied to the procedure itself, data of this kind can be presented even with quantitative indices, and will give an instructive picture of the logical habits of the thinker in question. How it can work actually was indicated above by the Logic-analysis (to be sure, elementary and tentative) of the reasoning of Dewey, Heraclitus, and Parmenides. The writer ventures to call this kind of investigation Logic-analysis, by analogy with Psycho-analysis. Psycho-analysis, in spite of its many defects, exaggerations, and misuses, has to its credit one great merit. Before Psycho-analysis, Psychology scored many different achievements. It made general laws and definitions; it accumulated a certain collection of actual facts partly supporting the general principles, partly showing their limitations; it conducted many experiments in special laboratories; under the rather misleading name of "individual differences" it studied how different characteristics are distributed in different sub-groups of a large group, but as to applications of general rules to concrete cases, that is to say, to actual individuals in their actual setting, Psychology generally (with maybe the partial exception of measurements of intelligence) was not quite successful. Psycho-analysis was first to take an individual as a continuum from his birth to the last moment of his existence and to centre its interest on the interpretation of the mental life of individuals in the light of certain principles rather than on the abstract principles themselves. The same situation is at present taking place in Logic. The traditional Logic, with all its abstract rules and technicalities, can deal with reasoning only when it is artificially chopped into minute bits, isolated and lifeless. The only actually existing reasoning, the continuous and, at any moment, unique flux of thought of a living and changing individual, is entirely beyond the reach of Logic in its present form. These living, first-hand, cognitive experiences, we hope, will be more accessible to Logic-analysis based on Dynamic Logic.

The next two suggestions—the tests for measuring quantitative intelligence and the construction of a Symbolic Logic with symbols of thought-units admitting all values between 0 and 1—have already been discussed above at length and must here be only mentioned (see Chapters VII, p. 192f and VIII, p. 247).

The last point to be discussed here is one of the bearings of Dynamic Logic on intellectual social relations. From the beginning of civilization, one of the greatest handicaps to successful social co-operation and creative good-will has been Intolerance. To be sure, not intellect nor reason is primarily responsible for Intolerance. It is not of a cognitive nature only; it is essentially an attitude, emotion, passion. But, on the other hand, Intolerance can express and crystallize itself only round certain ideas, certain statements. Without an idea conveying its contention, it can neither spread nor grow. But what is most important in the whole situation is the fact that Intolerance nearly always poses as a mainly intellectual, rational, and cognitive issue. In this aspect, Intolerance is much assisted and even fostered by Static Logic. A mind dogmatically convinced that if A is B, it by no means and in no degree can be non-B, a mind accustomed to hard and fast demarcation-lines and to absolutistic, unmodifiable judgments, in other words, the logically static mind, is a well-tilled soil for Intolerance

As a reaction against Intolerance, and largely as a product of recent years, another very destructive attitude has arisen—Indifference Nowadays one not infrequently meets people who will not accept any ethical principles, for, as they say, "No ethical code is perfect." For the same reason, other people have difficulties in following their religious convictions, feeling that "other quite different religions are quite good also" Sometimes this kind of attitude prevents its adherents from having any definite opinion even on the most important issues. It seems to them that none of the proposed solutions of the problem before them is quite acceptable, but, as they say, on the other hand, "in a certain sense" all the solutions are true. The worst of it is that this weakening and disintegration of cognitive life is sometimes mistaken for tolerance. Certain epithets like "open-minded" and "without prejudices," very complimentary not long ago, are now acquiring a dubious flavour. Having induced someone to accept some profitable but ethically rather questionable business combination, or to perform some well-paid but not quite honourable service, a shrewd and "aggressive" speaker will often say "This is splendid! I knew that you were a man without prejudices" Sometimes a warning like the following may be heard in a friendly conversation: "You had better watch your step with that fellow. He is awfully smart and, you know, 'open-minded,' as he styles himself, so one can expect everything from him" This indifference, indefiniteness, mental bonelessness is logically connected with quantitatively unmodified dynamic reasoning. If any A is merely both B and non-B, if any statement is equally acceptable and unacceptable, then Indifference comes inevitably to a mind devoid of sense of proportion and logical tact.

The best remedy against both Intolerance and Indifference is genuine Tolerance.

Its cognitive counterpart is a firm belief in one's own convictions, readiness to change them if sufficient evidence comes, and a regard for other and different convictions in proportion to the degree of their acceptability.

Its logical foundation is the acceptance of the continuity of thought-units and of their quantitative modification; in other words, the acceptance of Dynamic Logic.

APPENDIX

A list of the pairs of opposites used by **Dewey** in his *Democracy and Education*, and *How We Think*[1]

Living being—dead matter
Maturity—immaturity
Child—adult
Young child—young animal
School—life
Community—group
Consensus—lack of like-mindedness
Poor experience—meaningful experience
Living alone—living together
Living with others—deliberate education
Practical aims of institutions—cultural value of institutions
Vital—dead
Present-personal—remote
Formal—informal
Incidental—intentional
Physical forming—education
Active—passive
Thinking—overt act
Education—training
Individual—society
Muscular habits—desires
Idea (of word)—sound
Savages—modern nations
Environment—environing circumstances
Chance environment—design environment
Usual environment—simplified environment
Guidance—ruling
Environment—individual
Adaptation of environment—adaptation to environment
Fixed habits (routine)—intelligence
Conformity—uniformity
Child's end—educator's end
"Natural"—horseplay

Realistic—idealistic
Natural—arbitrary
Faculty—function
Selection—at random
Subject-matter—activities
Innate faculties—influence of environment
Learning—instructing
Present—past
Present—future
Conscious—unconscious
Recapitulation—creative development
Heredity—environment
Process—product
Meaningful—blind
Routine—capricious
General—particular
Social—personal
Normative—descriptive
Family—gang
Masters—slaves
Natural—social
Agent—his end
Interest—discipline
Initiation—completion
Executive persistence—intellectual planning
Knowledge—things
Intelligent—stupid
Mind—training
Internal (in art)—external
Mental—physical
Practice—theory
Fine arts—industrial arts
Leisured classes—labouring classes
Utilitarianism—culture
Drill—understanding
Trying—undergoing
Senses—muscles
Relations—things (facts)

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[1] The list does not pretend to be complete and exhaustive but it is fairly representative. The pairs of opposites are not arranged in any definite order

Judgment—perception
Experience—theory
Idea—word
Reasoning—trial and error
Imagination—overt action
Partially—impartially
Showing—keeping out of data
Information—thinking
Pure sciences—applied sciences
Formal education—life education
Humanity—state
Inquiry—prejudice
New—old
Man—citizen
Private men—rulers
National—international
Ends—results
Activity—(its) object
Freedom of action—influence of environment
Men—things
Instinctive—learned
Mind—body
Individual differences — general likeness
Understanding—training
Spiritual ideals—earning living
Values—communicable
Culture—nature
Culture—efficiency
Individual—average
Participant—spectator
Attitude of man — objective changes
Intellectual—volitional
Organism—environment
Objective—subjective
Self—world
He lost himself in the affair—he found himself
Initial stage—completing period
Stimulus—response
Immediate (stimulus) — remote (stimuli)
Direction—independent development
Moral (results)—physical (results)
Spontaneous—imposed
Personal influence — common pursuit
Sensory impression — meaning
Physical—mental
Individuality—like-mindedness
Physical (direction) — social (direction)
Language — prevailing habits of using things
External adjustment—conscious intent
Imitation—similar response
Ends—means
Cause—effect
Civilization—barbarism
Positive—negative
Comparative—final
Relative—absolute
Dynamic—static
Power—dependence
Physical incapacity — social capacity
Social—egoistical
Personal independence — social capacity
Plasticity—fixity (rigidity)
Specialized power (of animals) —multitude of instincts (of man)
(Control of the) body—(control of) environment
Genuine—artificial
One's own problem—teacher's problem
Human being—pupil
Observation—telling (reading)
Learning—teaching
Method—subject-matter
Eating—food
General method—originality of student
Quantity—quality
Directness—self-consciousness
Open-mindedness—empty-mindedness
Mental process—correct answers
Play—work
Personal experience—telling
Logical—psychological
Naturalism—humanism
Things—signs
Mediate—immediate
Facts—imagination
Intrinsic (values)—instrumental (values)
Leisure—labour
Intellectual studies—practical studies
Experience—true knowledge
Individual—world
Vocational—liberal
Continuity—dualism
Intellect—emotions
Knowing—doing
Inner—outer
Duty—interest
Knowledge—conduct

THE PAIRS OF CONTRASTING CONCEPTS TREATED BY DEWEY IN HIS *Interest and Effort* AS CONTINUOUS AND INSEPARABLE

Activity without interest versus activity with interest (pp. 18–19).—"The condition either of total lack of interest or of impartially distributed interest is as mythical as the story of the ass in scholastic ethics" (p. 19).

Interest without object (interest generally) versus interest with object (pp. 19–20).—"If we cut out an object about which interest clusters, interest itself disappears, relapsing into empty feeling" (p. 19).

The emotional element versus the objective element of interest.—"Value is not only objective but also subjective."

Direct interest versus indirect interest (pp. 21–45).—"There is no rigid insurmountable line between direct and indirect interest" (p. 36). "Strictly speaking, there is no such a thing as exclusively direct interest." "Even a baby interested in pulling a saucer with a spoon is not concerned with a purely momentary reaction and excitement" (p. 44). "Not only, however, does the direct interest in an object pass thus gradually and naturally into indirect interest, as the scope of idea is prolonged, but the reverse process also takes place. Indirect value becomes direct" (p. 38).

Means versus ends (pp. 21–32).—In the case of direct and immediate action, "the end is the present activity, and so there is no gap in the mind between means and ends" (p. 21). "Division into means and ends hardly has any meaning" (in the illustration of eating of a meal in civilized society) (p. 29). In the light of continuity of direct and indirect interest it becomes a general statement.

Stages of a process versus process as a whole.—"The musical theme heard may represent a step in a more continuous process of musical education" (p. 31). "Each molding of the clay, each stroke of the chisel is for him [an artist—B. B. B.] at the time the whole end in process of realization" (p. 27).

Effort versus end to be reached (pp. 47–48).—"Apart from an end to be reached, effort would never be anything more than a momentary strain or a succession of such strains" (p. 4).

Dislike versus longing (p. 49).—This is a very illuminating and representative sample of dynamic logic. Two quite contradictory characteristics are, by definition, attributed to any smallest bit of combination of effort. "Effort as a mental experience is precisely this peculiar combination of conflicting tendencies, tendencies away from, and tendencies towards dislike and longing" (p. 49).

Weakening of the impetus versus strengthening it (pp. 51–53).—This example is of the same kind as the one just mentioned. "This experience of resistance has a double effect, though in a given case one effect may predominate and obscure the other. . . . One effect is weakening of the impetus in the forward direction . . . . On the other hand, meeting an obstacle may brace him [the person who met the obstacle—B. B. B.], invigorate him in his effort to achieve the end" (p. 51).

Easy versus difficult (pp 55–60).—Activity must be both easy, in order to be possible to perform, and difficult, in order to be stimulating The right kind of educative activity is " when the work to be done is of a nature to make an appeal to him [a student—B. B. B.] or to enlist his powers, and when the difficulties are such as to stimulate instead of depressing " (p 58) The continuous nature of easy and difficult is also well expressed in the following " paradox " " Strange as it may seem to say it, one of the chief objections both to mechanical drill work, and to the assigning of subject-matter too difficult for pupils, is that the only activity to which they actually incite the pupils is in kind too easy for them " (p 57)

Motive versus its object (pp 60–63) —" A word of warning may be in place against taking the idea of motivation in too personal a sense, in a sense too detached, that is, from the object or end in view " (pp 60–61)

Process, function, versus its product (pp 63–64) " Another consequence of a too personal conception of motivation is a narrow and external conception of use and function We shall not insist upon tangible material products, nor upon what is learned being put to further use at once in some visible way " (pp 63–64).

Physical versus mental (pp 68–70) —" As far as a physical activity has to be learned it is not merely physical but is mental, intellectual, in quality " (p 68) Because most, if not all, physical activities are modified by practice, that is, are capable of being learned, this statement may be taken as a general one

Function of sense organs versus motor responses (pp 70–71) " The sense organs are simply the pathways of stimuli to motor-response, and it is only through the motor-responses and especially through consideration of the adapting of sense-stimulus and motor-responses to each other that growth of knowledge occurs " (p 71)

Work versus play (pp 77–80) —" The use of intervening tools distinguishes games and work from play " (pp 76 and 101) " There is, of course, no sharp distinction either in practice or in principle between this form of activity [games—B B B] and the more direct kind just discussed [play—B B B] The organs of the body—especially the hands—may be regarded as a kind of tools whose use is to be learned by trying and thinking Tools may be regarded as a sort of extension of the bodily organs " (p 75)

Intellectual or theoretical interest versus constructive practical interest (pp 81–83) —" The intellectual interest is not a new thing now showing itself in the first time " [and ff]. " As there is no sharp line of division in theory, so there is none in practice " (p 82).

Interest towards persons versus interest towards things (pp 85–87) — " Adults are so accustomed to making sharp distinctions between their relations to things and to other persons . so that it is difficult for them, practically impossible, to realize the extent to which children are concerned with things only as they enter into and affect the concerns of persons, and the extent to which a personal social interest radiates upon objects and gives them their meaning and worth " (p 86) Because of the continuity of child and adult, what is said here about children may be accepted as a general statement

Moral interest versus social interest (pp 87–89) —" It is not necessary to do more than to allude to the close connections between social and moral interests " (p 88)

Mind versus activity (p 92) —" Anyone who has grasped the conception of an interest . . . will never fall into the error of thinking of mind (or of the self) as an isolated inner world by itself . . Mind is one with intelligent or purposeful activity " (p 92)

Mind versus environment (pp 92–94) —" The false sense of abstraction is connected with thinking of mental activity as something that can go on wholly by itself, apart from objects or from the world of persons or things " (p. 92).

Mind versus subject-matter (pp. 94–95) —" The supposed externality of subject-matter is but the counterpart phase of the alleged internal isolation of mind If mind means certain powers or faculties existing in themselves and needing only to be exercised *by* and *upon* presented subject-matter, the presented subject-matter must mean something complete in its ready-made and fixed separateness " (p 94)

Interest versus conditions backing it (pp. 95–96) —At the end, as the concluding word of the long battle against separation, warning is given not to fall into the error of considering even the broadest generalisation and the core of the whole discussion, interest itself, as something isolated, independent, exclusive, and self-important

" Hence it follows that little can be accomplished by setting up 'interest' as an end or a method by itself Interest is obtained not by thinking about it and consciously aiming at it, but *by considering and aiming at the conditions* that lie back of it, and compel it " (p 95)

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